REACH to the UNKNOWN

the Trinity story July 16, 1945

THE ATOM

Los Alamos Scientific Laboratory July 16, 1965

Special anniversary edition written by John Savage and Barbara Storms
July 16, 1965
Volume 2 Number 8

Published monthly by the University of California,
Los Alamos Scientific Laboratory, Office of Public Relations,
P.O. Box 1663, Los Alamos, New Mexico, 87544.
Second Class Postage paid at Los Alamos, New Mexico.

Editor: Earl Zimmerman
Photography: Bill Regan and Bill Jack Rodgers
Contributors: Members of the PUB staff

Office: D-413 Administration Building. Telephone: 7-5236.
Printed by The University of New Mexico Printing Plant, Albuquerque.

ON THE COVER:

Although colored movies were taken of the Trinity test, they were of poor quality and have since deteriorated. This cover photograph, also showing the ravages of 20 years, is the only existing color shot of the test. It was taken, surprisingly enough, by an amateur using his own camera. Jack Aeby, now of H-6, was working at Trinity with Emilio Segre studying delayed gamma rays. Segre secured permission for Aeby to carry his camera to the site to record the group's activities. Came the test and, as Aeby says, "It was there so I shot it." The picture was taken from just outside Base Camp with a Perfex 33 camera using 35 mm film. The photograph provided the basis for the Theoretical Division's earliest calculations of the Trinity weapon's yield and was shortly confiscated by the Army and first published after the announcement was made of the bombing of Japan.

Los Alamos Scientific Laboratory,
an equal opportunity employer,
is operated by the University of California
for the United States Atomic Energy Commission

REACH to the UNKNOWN

"We were reaching into the unknown and we did not know what might come of it . . ."

Brig. Gen. Thomas F. Farrell
Report to the War Department
July 18, 1945

The twentieth anniversary of the Trinity test of July 16, 1945 is the occasion for telling the story of one of the greatest scientific achievements of all time.

The tale is told here in two parts: Part I, the story of the Trinity test, and Part II, the story of how the bomb was built.

foreword

The rain stopped at 4:00 a.m. The decision to proceed with Project Trinity was announced at 5:10. Nineteen minutes and 45 seconds later the desert of the Jornada del Muerto grew brighter than it had ever been before, even on the hottest summer noon.

The date was July 16, 1945. Man's first attempt to produce a nuclear explosion had succeeded. One direct result would be the end of the second World War. Twenty years later, as this account goes to press, some of the other results are still beyond calculation.

The atomic device used on that morning was called the Fat Man. It was a heavy sphere, about five feet tall. Its essential components included a core of plutonium metal, a surrounding layer of high explosive, and a large number of electrical detonators that looked a little like spark plugs. It had cost—according to the most sensational of many possible ways of figuring—a little less than two billion dollars.

Though the Fat Man had been designed and built at Los Alamos, New Mexico, it owed much of its success to people in other places. The first atomic explosion marked the climax of a nationwide research and development program.

PART I

TRINITY

by BARBARA STORMS

In the huge complex of organizations devoted to the wartime development of the atomic bomb, the Los Alamos Project (Project Y) was small. But it was crucial. While other groups worked toward the development and production of nuclear materials, "the laboratory," its newly-appointed director was told early in 1943, "will be concerned with the development and final manufacture of an instrument of war."

The success of the entire undertaking, known collectively as the Manhattan Engineer District of the War Department, was dependent on the success of the small, isolated laboratory high in the mountains of New Mexico. And to J. Robert Oppenheimer, slight, soft-spoken, intellectual physics professor from the University of California, went the immense responsibility for guiding the project to a successful conclusion.

What he needed first were the men. From universities and laboratories all over the country he recruited the nation's most outstanding scientists. They were soon joined by a contingent of British researchers sent, by joint agreement between the two governments, to share in the work. Together they made up what Maj. Gen. Leslie R. Groves, director of the Manhattan District, once admiringly referred to as "the finest collection of crackpots the world has ever seen." For all of them, their fascination with the work ahead and their comprehension of its importance was enough to prompt them to leave their posts and disappear with their wives and children into the dust, mud and secrecy of the ramshackle community that became Los Alamos.

Equipment was assembled, too. A cyclotron was borrowed from Harvard, two electrostatic accelerators from the University of Wisconsin, and a Cockcroft-Walton accelerator from the University of Illinois. Other research tools, designed and built at Los Alamos, were soon added and the buildings went up, virtually around them. The laboratory grew quickly and became, as the historic Smyth Report of 1945 described it, "probably the best-equipped physics research laboratory in the world."

Within months the first experiments were well underway in the search for answers to the overwhelming problems (described in Part II) that faced the pioneers on the mountain.

Development of the gun-type uranium weapon, which was to become "Little Boy", moved confidently ahead, but work on implosion (the method in which a subcritical mass of plutonium is compressed to supercriticality by high explosives) was slow, frustrating and often seemingly hopeless. By late 1943 it was evident that there was no alternative: the implosion device would have to be tested.

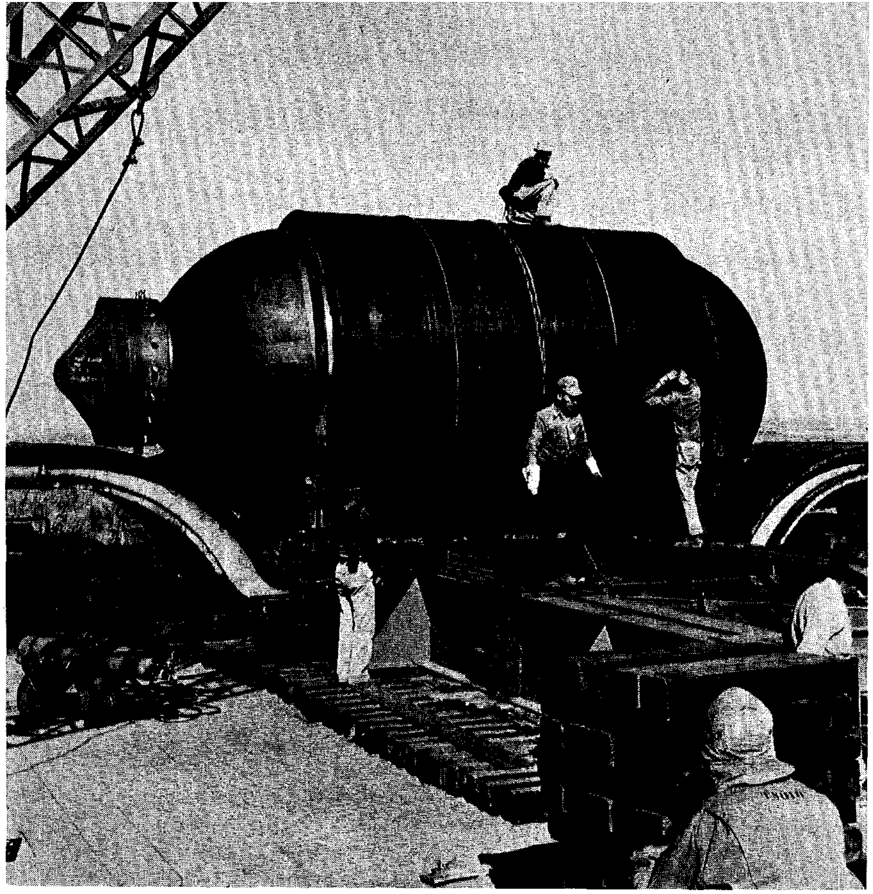
Too many questions would be left unanswered. A nuclear explosion was so entirely new, the implosion method so far removed from any existing practice, the construction of the atom bomb so entirely dependent on dead reckoning, that no one was willing to risk the first trial of such a device over enemy territory or even in demonstration for the Japanese, as had been suggested, where a failure would wipe out the crucial psychological effects of so monumental a weapon.

Furthermore, it was essential to obtain detailed and quantitative information on the various effects of the new weapon which would serve as basic technical data for tactical planning in the future. Little of this could be obtained if the explosion were first observed under combat conditions.

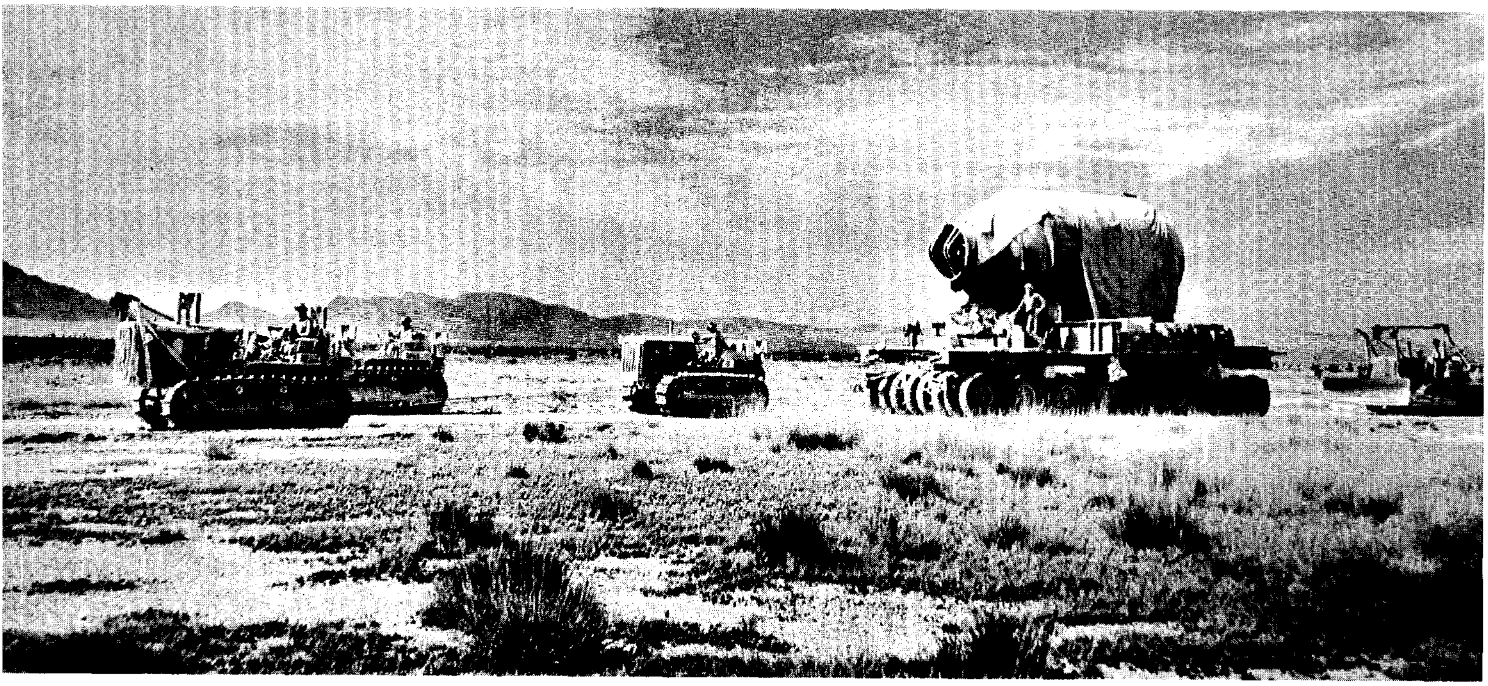
One important question, about which there was substantial disagreement, concerned the explosive force to be expected. Only an actual nuclear detonation could settle that question, and then only if meaningful measurements (requiring many new techniques) could be made.

Other questions concerned the performance of the implosion system inside the device; the destructive effects of heat, blast, and earth shock; radiation intensities; fallout; and general phenomena (fireball, cloud, etc.) associated with the explosion.

And so the decision was made to sacrifice what was to amount to one third of the nation's stockpile of atomic weapons and its entire supply of plutonium on a secret test on American soil.



Jumbo, the tremendous steel vessel designed to contain the explosion of the first atomic device, arrived at the siding at Pope, New Mexico, in the spring of 1945. Container was 25 feet long and weighed 214 tons.



A special 64-wheel trailer was required to carry Jumbo across the desert to Trinity site. By this time, scientists had more confidence in the implosion device and recovery plans had been abandoned.

the plans

The first formal arrangements for the test were made in March 1944 with the formation, in George Kistiakowsky's Explosives Division, of group X-2 under the leadership of Kenneth T. Bainbridge, whose duties were "to make preparations for a field test in which blast, earth shock, neutron and gamma radiation would be studied and complete photographic records made of the explosion and any atmospheric phenomena connected with the explosion."

With doubt and uncertainty hanging over the project throughout 1944 it is not surprising that one of the first and most heavily emphasized efforts in the test preparations was planning for the recovery of active material in case the nuclear explosion failed to take place. In 1944 there was barely enough plutonium available to conduct the essential experiments and the outlook for increased production was dim. It seemed absolutely essential that the active material not be wasted in an unsuccessful test.

Scientists toyed with the idea of using a water recovery method in which the bomb, surrounded by air space, would be suspended in a tank of water and fragments would be stopped by a 50 to 1 ratio of water to high explosive mass. They also investigated the possibility of detonating the bomb over a huge sand pile and putting the sand through placer operations to mine whatever plutonium might be imbedded there. Neither of these methods appeared particularly promising and the decision was made early in the game to attempt to contain the blast in a huge steel vessel.

Although the container, promptly dubbed Jumbo, became a high priority project at the outset and all test plans, until the last minute, were based on the assumption that it would be used, there is little evidence that the idea met with much enthusiasm in Los Alamos.

As early as March 10, 1944, Oppenheimer wrote to General Groves outlining the plans and possibilities for "a sphere for proof firing", pointing out that "the probability that the reaction would not shatter the container is extremely small." He promised, however, that the Laboratory would go ahead with plans and fabrication of the vessel.

But this was easier said than done, and by the following summer Jumbo had become the most agonizing of the project's endless procurement headaches.

In late March, Hans Bethe, head of the Theoretical Division, wrote in a memo to Oppenheimer that because of the numerous engineering problems, which he described in discouraging detail, "the problem of a confining sphere is at present darker than ever."

But the problem was tackled, nonetheless, by section X2-A of Bainbridge's group with R. W. Henderson and R. W. Carlson responsible for engineering, design and procurement of the vessel. In May scale model "Jumbinos" were delivered to Los Alamos where numerous tests were conducted to prove the feasibility of the design.

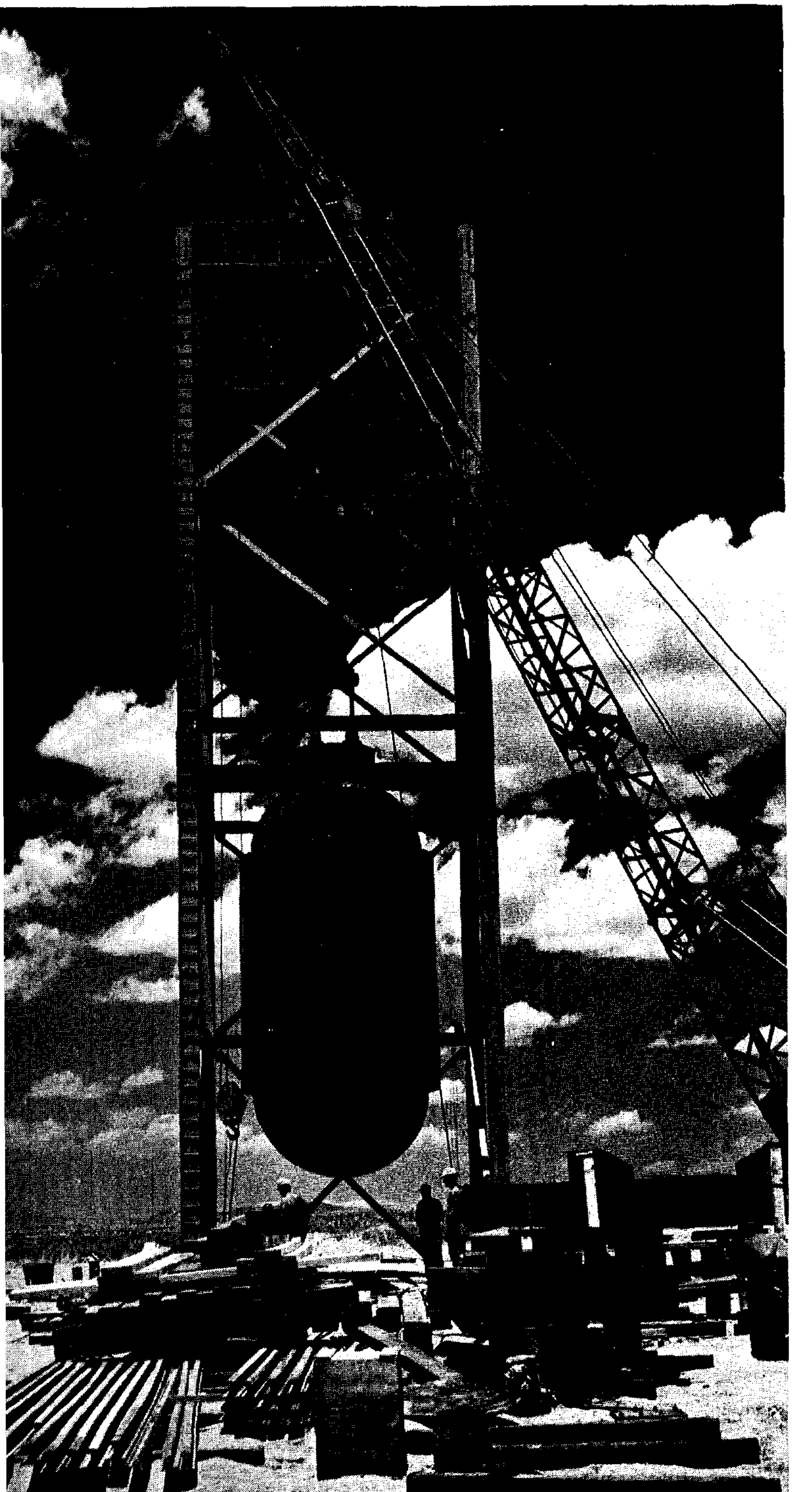
Feasible though the design appeared to be, there was scarcely a steel man in the country who felt he could manufacture the container. Specifications required that Jumbo must, without rupture, contain the explosion of the implosion bomb's full complement of high explosive and permit mechanical and chemical recovery of the active material. To do this required an elongated elastic vessel 25 feet long and 12 feet in diameter with 14 inch thick walls and weighing 214 tons.

Personal letters explaining the urgency of the project and the importance of the specifications went out from Oppenheimer to steel company heads, but by May 23, 1944, Oppenheimer was forced to report to his Jumbo committee that the steel companies approached had expressed strong doubts that Jumbo could be manufactured to specifications. Meanwhile, he told them, feasibility experiments would continue in the Jumbinos and the order for the final vessel would be delayed a little longer.

Eventually, the Babcock and Wilcox Corporation of Barberton, Ohio agreed to take a crack at the job and the order was placed in August, 1944. The following spring the tremendous steel bottle began its roundabout trip from Ohio on a specially built flat car, switching from one route to another wherever adequate clearance was assured. In May 1945, the jug was delivered to a siding, built for the purpose by the Manhattan District, at Pope, New Mexico, an old Santa Fe railroad station that served as a link with the Southern Pacific and the Pacific Coast in the 1890's. There it was transferred to a specially built 64-wheel trailer for the overland trip to the test site.

But it was too late. During the last months before the test, all of the elaborate recovery schemes were abandoned. By then there was greater promised production of active material, there was greater confidence in the success of the bomb and, more importantly, there was increasing protest that Jumbo would spoil nearly all the sought-after measurements which were, after all, the prime reason for conducting the test at all.

The fate of Jumbo, however, was not absolutely settled until the very last minute. On June 11, 1945, just a month before the test, Bainbridge, in a memo to Norris Bradbury, present Laboratory director and



At Trinity, Jumbo was erected on a tower 800 feet from Ground Zero. It survived the explosion unscathed.

then in charge of bomb assembly, wrote that "Jumbo is a silent partner in all our plans and is not yet dead. . . . We must continue preparations for (its) use until Oppenheimer says to forget it for the first shot."

And a silent partner it remained. Ultimately the magnificent piece of engineering was erected on a tower 800 feet from Ground Zero to stand idly by through the historic test.

Once the decision has been made, in the spring of 1944, to conduct the test, the search began for a suitable test site. Los Alamos was ruled out immediately for both space and security reasons and the search spread to eight possible areas in the western United States.

To please the scientists, security and safety people alike, the site requirements were numerous. It had to be flat to minimize extraneous effects of the blast. Weather had to be good on the average with small and infrequent amounts of haze and dust and relatively light winds for the benefit of the large amounts of optical information desired. For safety and security reasons, ranches and settlements had to be few and far away. The site had to be fairly near Los Alamos to minimize the loss of time in travel by personnel and transportation of equipment, yet far enough removed to eliminate any apparent connection between the test site and Los Alamos activities. Convenience in constructing camp facilities had to be considered. And always there was the ever-present question: Could Jumbo be readily delivered there?

Throughout the spring a committee, composed of Oppenheimer, Bainbridge, Major Peer de Silva, Project intelligence officer, and Major W. A. Stevens, in charge of maintenance and construction for the implosion project, set out by plane or automobiles to investigate the site possibilities. They considered the Tularosa Basin; a desert area near Rice, California; San Nicholas Island off Southern California; the lava region south of Grants; an area southwest of Cuba, New Mexico; sand bars off the coast of South Texas; and the San Luis Valley region near the Great Sand Dunes National Monument in Colorado.

By late summer the choice was pretty well narrowed down to part of the Alamogordo Bombing Range in the bleak and barren Jornada del Muerto (Journey of Death). The area had the advantage of being already in the possession of the government and it was flat and dry although almost constantly windy. The nearest inhabitant lived 12 miles away, the nearest town, Carrizozo, was 27 miles away. It was about 300 miles from Los Alamos.

The Jornada del Muerto derives its grim name from its barren, arid landscape. Old Spanish wagon trains headed north would be left to die in the desert if they ran into trouble since they could depend on finding neither settlement nor water for 90 miles or so.

On August 14 Oppenheimer wired Groves in Washington that he thought there would be no problem in obtaining the land for their purposes but, concerned as usual about Jumbo, specified that "the northern part will be satisfactory to us provided the El Paso-Albuquerque line of the Santa Fe can carry a 200-ton load either from El Paso north or from Albuquerque south to the neighborhood of Carthage."

The final decision was made on September 7, 1944 and arrangements were made at a meeting with the commander in chief of the Second Air Force for acquisition of an 18-by-24-mile section of the northwest corner of the bombing range.

Not long afterward, when it became necessary to choose a code name for the test, it was Oppenheimer who made the selection. Many people have tried to interpret the meaning of the name but Oppenheimer has never indicated what he had in mind when he chose Trinity. In any case, it did create some confusion at first.

Bainbridge asked Oppenheimer for clarification in a memo written March 15, 1945:

"I would greatly appreciate it if the Trinity Project could be designated Project T. At present there are too many different designations. Muncy's (Business) office calls it A; Mitchell's (Procurement) office calls it Project T but ships things to S-45; and last week it was christened Project J. By actual usage, people are talking of Project T, our passes are stamped T and I would like to see the project, for simplicity, called Project T rather than Project J. I do not believe this will bring any confusion with Building T or Site T."

Nothing was simple in preparations for the test and the securing of maps of the test site was no exception. Lest Los Alamos appear involved, the job was handled by the Project's security office which managed to avoid pinpointing the area of interest by ordering, through devious channels, all geodetic survey maps for New Mexico and southern California, all coastal charts for the United States, and most of the grazing service and county maps of New Mexico. There was considerable delay while the maps were collected and sorted.

Despite the many complicated steps taken to avoid any breech of security there were a few snafus. As soon as construction began on the test site it became necessary to have radio communication within the site so that radio-equipped cars could maintain contact with the guards and with people at the various parts of the area. Later, communication would be essential between the ground and the B-29s participating in the test. A request went out to Washington for a special, exclusive wave length for each operation so that they could not be monitored.

Months went by and at last the assignments came back. But alas, the short wave system for the ground

A portion of the Alamogordo Bombing Range was chosen as the site for the Trinity test. This section of the test site was located at McDonald ranch which served as assembly headquarters for the atomic device.

was on the same wave length as a railroad freight yard in San Antonio, Texas; the ground to air system had the same frequency as the Voice of America.

"We could hear them (in San Antonio) doing their car shifting and I assume they could hear us," Bainbridge reported later. "Anyone listening to the Voice of America from 6 a.m. on could also hear our conversations with the planes."

On the basis of a thorough Laboratory survey of proposed scientific measurements to be made at the test, justification for all construction and equipment requirements was sent in a detailed memo to Groves on October 14. On November 1 Groves wired Oppenheimer his approval of the necessary construction but asked that "the attention of key scientists not be diverted to this phase unnecessarily."

He needn't have worried. By August the outlook for the implosion program had turned bleak indeed. The test preparations lost their priority and the Laboratory turned nearly all its attention toward overcoming the serious difficulties that were developing. Urgency in securing manpower for research and development on the problem was so great that all of Bainbridge's group, except for a few men in Louis Fussell's section X-2c, were forced to abandon their work on the test and concentrate on development of a workable detonating system and other top priority jobs lest there be no test at all.

Between August and February, however, Fussell's section did manage to work on such preparations as acquiring and calibrating equipment, studying expected blast patterns, locating blast and earth shock instruments, and installing cables to determine electrical and weather characteristics, in addition to the design and construction of the test site Base Camp and the design and contract for Jumbo —about all the test program could demand with the plight of implosion so desperate.

Contracts were let early in November for construction of Trinity camp, based on plans drawn up by Major Stevens in October. The camp was completed in December and a small detachment of about 12 military police took up residence to guard the buildings and shelters while additional construction continued.

As the new year arrived, the implosion work began to show more promise and the Research Division under R. R. Wilson was asked to postpone even its highest priority experiments and turn its four groups, under Wilson, John Williams, John Manley, and Emilio Segre, to developing instruments for the test.

By February the Laboratory was mobilizing. Oppenheimer had long since been committed in Washington to a test in July and the deadline was fast approaching. In a conference at Los Alamos, attended by General Groves, it was decided then and there to freeze the implosion program and concentrate on one of several methods being investigated—lens implosion with a modulated nuclear initiator. The conference then outlined a detailed schedule for implosion work in the critical months ahead:

April 2: full scale lens mold delivered and ready for full scale casting.

April 15: full scale lens shot ready for testing and the timing of multi-point electrical detonation.

March 15- April 15: detonators come into routine production.

April 15: large scale production of lenses for engineering tests begin. (Lenses direct explosive's shock waves to suitable converging point.)

April 15-May 1: full scale test by magnetic method.

April 25: hemisphere shots ready.

May 15-June 15: full scale plutonium spheres fabricated and tested for degree of criticality.

June 4: fabrication of highest quality lenses for test underway.

July 4: sphere fabrication and assembly begin. By the following month the schedule had already been shifted to establish July 4 as the actual test date and that was only the beginning of the date juggling.

Overall direction of the implosion program was assigned early in March to a committee composed of Samuel K. Allison, Robert Bacher, George Kistiakowsky, C. C. Lauritsen, Capt. William Parsons and Hartley Rowe. For its job of riding herd on the program the committee was promptly dubbed the Cowpuncher Committee and it was the Cowpunchers who had the responsibility for the intricate job of integrating all the efforts of Project Y, the arrival of critical material from Hanford and the activities at Trinity site in order to meet the test deadline.

Trinity Base Camp was built by the Army in the winter of 1944 and was occupied by a detachment of military police from December on. By summer it was a bustling hive of activity with more than 200 scientists, soldiers and technicians.

trial run

Project Trinity, with Bainbridge as test director and William Penney and Victor Weisskopf as consultants, became an official organization and top priority project of the Laboratory in March 1945. At the same time Project Alberta, for combat delivery of the weapons, was organized under Capt. Parsons with N. F. Ramsey and Norris Bradbury as technical deputies.

Bainbridge was a Harvard physics professor with a background in electrical engineering and a three-year stint at the MIT Radiation Laboratory who had come to Los Alamos as a group leader in charge of high explosive development. As General Groves pointed out in his book, "Now It Can Be Told," Bainbridge was "quiet and competent and had the respect and liking of the more than 200 enlisted men later on duty at Alamogordo."

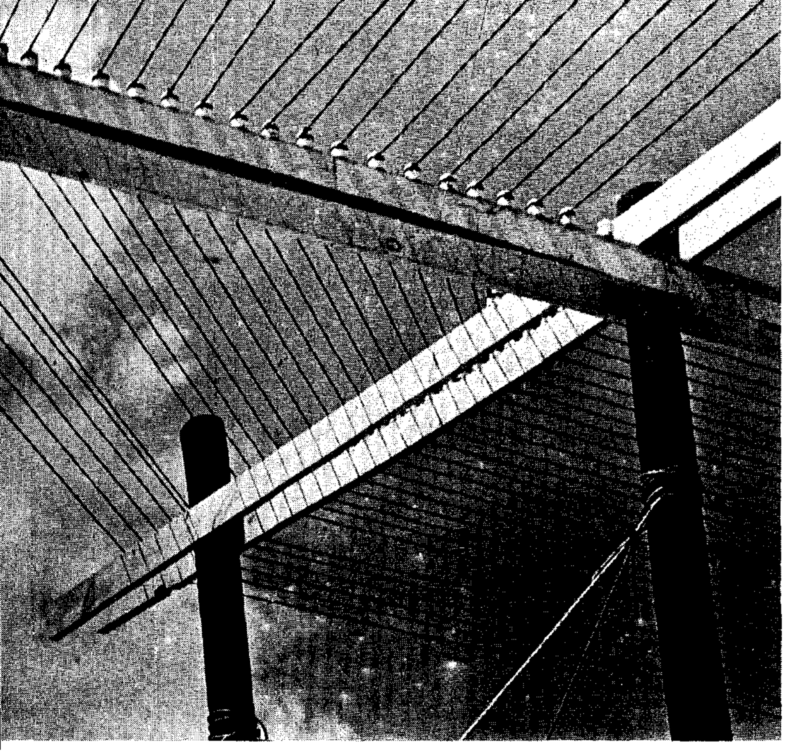
Bainbridge's first task was to rush his organization into preparations for a trial test—the detonation of 100 tons of conventional high explosives—which had been proposed in the winter of 1944 and scheduled for early May. Since very little was known, in 1945, about blast effects above a few tons of TNT, such a test would provide data for the calibration of instruments for blast and shock measurements and would serve as a dress rehearsal to test the operation of the organization for the final shot.

Meanwhile, a vast and complex laboratory was growing in several square miles of empty desert. There was a maze of roads to be built, hundreds of miles of wires to be strung over, on and under the ground, a complete communication system installed, buildings to be erected, supplies, equipment and personnel to be transported between Los Alamos and Trinity, all under the cloak of supreme secrecy.

The man who shouldered this monumental task was John H. Williams, leader of the Laboratory's Electrostatic Generator group, who became responsible for Trinity services as head of TR-1. As Bainbridge wrote later, "The correlation of the construction program and the proper and successful designation of construction aid was exacting work requiring 'superior judgment,' as the Army says, and long hours of hard work. This was done supremely well by Williams, to whom the Trinity project owes much for the successful completion of the operation." Bainbridge has also pointed out the invaluable assistance provided by Sgt. J. A. Jopp, who was in charge of all the wire installation and construction at the site.

Procurement of an incredible assortment of equipment ranging from Kleenex to elaborate scientific instruments was a seemingly insurmountable job handled by Robert Van Gemert, now alternate head of the Laboratory's Supply and Property Department, aided and abetted by Frank Oppenheimer who served as Bainbridge's trouble shooter.

By April the number of urgent purchase requests had increased so rapidly that it became necessary to inflate the urgency ratings that had been in use by



Hundred of miles of wires had to be strung between base camp, the control point, the instrument bunkers and Ground Zero—one of the countless jobs that kept men at Trinity working at a feverish pace throughout the spring and summer of 1945.

the Procurement Office. Until things got out of hand that spring, four ratings—X, A, B and C—had been used in order of decreasing priority. By early May, when everything seemed to warrant an X priority, it was announced that this super urgent rating would be subdivided into three others: XX, X1, and X2. XX would be used only if failure to obtain the material would produce a setback of major importance in the overall program of the Laboratory. It authorized the Procurement Office, through the Washington Liaison Office, to have recourse to the highest authority of the War Production Board and all government agencies and to use a special dispatch or cargo plane from anywhere in the United States to get delivery.

But the manufacturers were not impressed. Representatives from every armed service and government war project were pounding on their desks with equally high priorities and waiting six to 15 weeks for delivery while Trinity people were demanding three weeks delivery for the same item.

The problem was further complicated by the fact that there was no direct communication between the Project and the purchasing offices, nor could Los Alamos buyers talk directly to the scientists at the site to discuss possible substitutions or compromises on specifications.

Some items were just well-nigh impossible to get—like the seismographs that were needed to check earth shock at outlying areas around the state. The only instruments available were finally located at a firm which had already sold them to the Nazi-sympathizing Argentine government. It took an overriding directive, direct from General Grove's office, to get the instruments shipped to Trinity instead.

Another crisis came when 10,000 feet of garden hose were lost during a shipping strike. A second order was placed but by June 29 the hose was still on the list of critical items not yet on hand. The hose was used to encase cables to sensitive instruments to protect them from the weather.

Delayed delivery on a number of urgent requests led Oppenheimer to call a meeting in May to review the procurement situation. One of the principal reasons for the delays, it turned out, was the shortage of personnel in the Los Angeles, New York and Chicago purchasing offices. Although the number of requisitions had greatly increased there had been no increase in the number of buyers since January 1944, a situation blamed on salary restrictions. As a result of the meeting salary adjustments were agreed upon and more personnel secured for all three offices. Direct communications were established between the Project and the New York and Chicago offices and Project members were asked to submit improved drawings and specifications.

But slow or not, the materials did arrive and in June the amount of goods handled by the main warehouse at Los Alamos reached its peak. During May the warehouse handled an average of 35 tons a day, 89% of which was incoming; during June the daily average rose to 54 tons of which 87% was incoming, and during the first half of July it was 40 tons a day, 80% incoming. A new shipping group was organized that spring to handle the outgoing goods, most of them bound for Trinity or Tinian Island in the Pacific.

Plenty of local procurement problems remained. First there was communication. Only five people on the project were allowed to telephone between Trinity and Los Alamos and these calls were routed to Denver, on to Albuquerque and finally to San Antonio, New Mexico. Teletype service was so bad, Van Gemert recalls, that you never knew if the test site was asking for a tube or a lube job. It soon became evident that the best way to communicate was to send notes back and forth by the truck drivers.

At least two and often as many as ten trucks left Los Alamos every evening after dark to avoid both the blistering desert heat and unnecessary notice, and arrived at the test site early the next morning. Almost always there was a stop to be made at the U.S. Engineers yard in Albuquerque to pick up items addressed to Prof. W. E. Burke of the University of New Mexico's physics department, who served as a blind to avoid a connection between the items and Los Alamos.

"We'd get things to Trinity any way we could," Van Gemert says. Some of the ways were devious. A carload of telephone poles was desperately needed at the test site and no freight train was traveling fast enough to get it there in time. After considerable urging the Santa Fe railroad consented to attach the car to the rear of the Super Chief and sped the cargo to Albuquerque. Another time, for lack of freight space, 24 rolls of recording paper were luxuriously ensconced in a Super Chief drawing room for the trip from Chicago.

To supplement the special items, the Procurement people established a complete technical stockroom at the test site early in the game and trucked the entire stock from Los Alamos. The stockroom, known officially as FUBAR (fouled up beyond all recognition), was manned by enlisted men who used their spare time to manufacture the face shields needed to protect observers from the test blast. The shields were made of aluminum sheets, mounted on a stick handle, with welders' goggles for a window.

There never seemed to be enough people to take care of all the work to be done on the test preparations and those who were available, from mess attendants to group leaders, worked at a fever pitch. A ten hour day was considered normal and it often stretched to at least 18 hours.

In the spring of 1945 a big part of the Laboratory was reorganized to take care of the test and many people found themselves involved in activities far removed from their normal duties. John Williams, the high energy physicist, took the responsibility for construction and servicing of the base camp. John Manley was wrapped up in neutron measurements as a Research Division group leader when he suddenly found himself in charge of blast measurements for the test.

"I didn't know anything about blast measurements," he recalls 20 years later. "We'd never done anything like that before."

But talent is talent wherever it is found and the displaced crews managed expertly and efficiently to bring their remarkable tasks to a successful conclusion under extreme pressure.

Throughout the spring and summer there was a constant stream of personnel traveling between Site Y and Trinity in a motley assortment of busses and cars, some of them barely able to make the long, monotonous trip.

Security precautions were rigid. In March, Dana

The flag flew at half-mast at Trinity base camp on April 12, 1945 when word came of the death of Franklin D. Roosevelt. The president's death gave Harry S. Truman the responsibility for making the crucial decision on the eventual use of the atomic bomb.

P. Mitchell, assistant director of the Laboratory, issued terse, precise travel instructions:

"The following directions are strictly confidential and this copy is to be read by no one but yourself. You are to turn this copy in to me personally on your return to the site," the memo read, and continued with specific directions and mileages for reaching the site. "Under no condition," it went on, "when you are south of Albuquerque are you to disclose that your are in any way connected with Santa Fe. If you are stopped for any reason and you have to give out information, state that you are employed by the Engineers in Albuquerque. Under no circumstances are telephone calls or stops for gasoline to be made between Albuquerque and your destination."

Travelers were then instructed to "stop for meals at Roys in Belen, which is on the left-hand side of the main road going south. If you leave the site at 7 a.m. you should make this stop around lunch time."

Even so, by midafternoon when the travelers reached the little junction town of San Antonio, most of them were hot, tired and thirsty and Jose Miera's bar and service station became a popular, if illegal, stop. Miera still remembers the unusually heavy traffic in those days. One of his customers, John Manley, remembers Miera's wall of bottles.

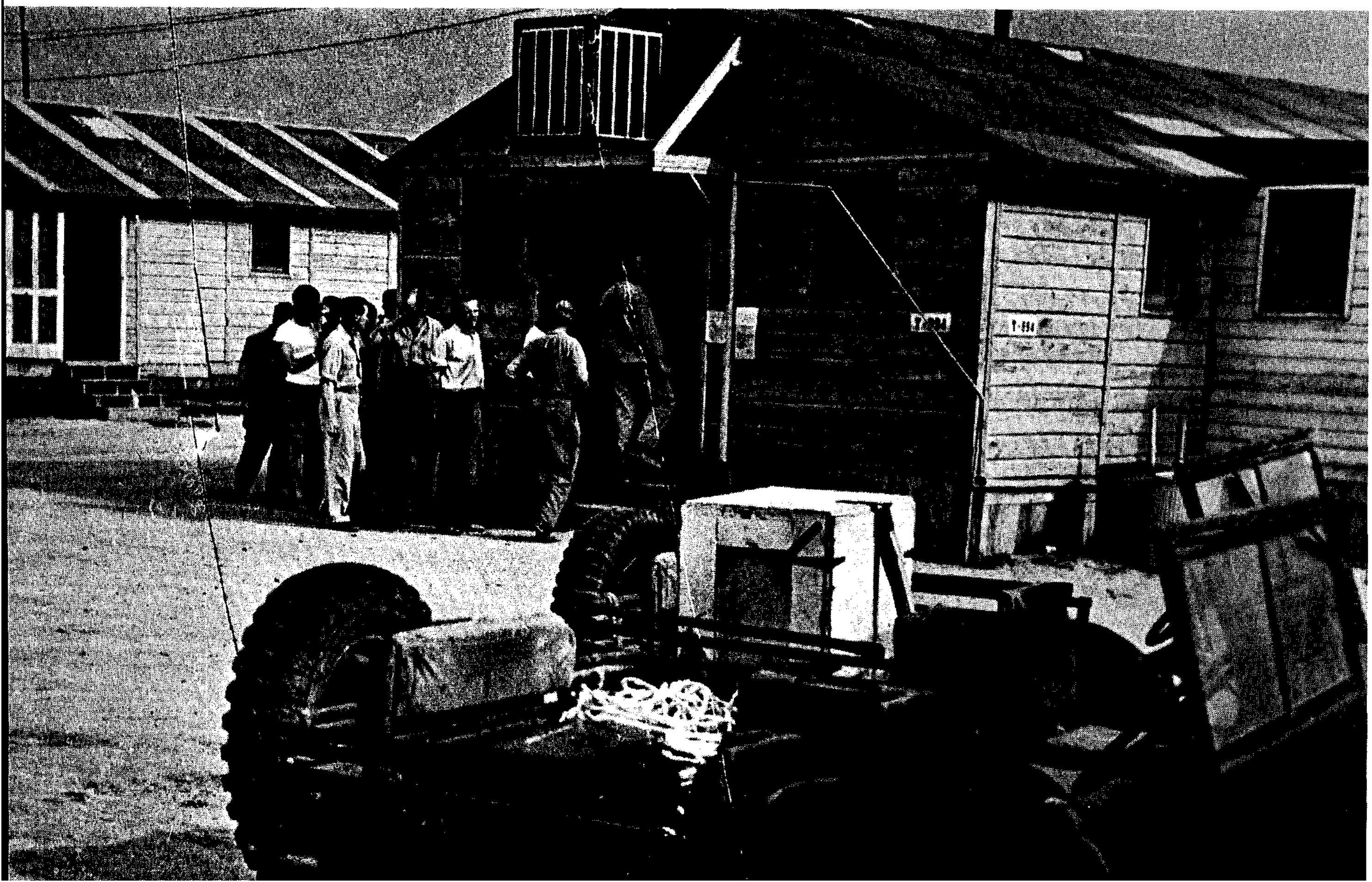
"He had the whole south wall of his place lined with bottles," Manley reports. "We used to worry an awful lot about that. If our big blast traveled that far, that's the wall it would hit." Luckily it didn't.

Additional regulations required that all departing groups and individuals stop at the office of the intelligence officer for an explanation of "the security objectives of Trinity." All personnel were required to sleep and eat at the camp rather than in nearby towns, and recreation trips for movies and dinners to nearby towns were prohibited to officers, enlisted men and civilians alike.

In addition, all Trinity-bound personnel were required to report their impending departure to Oppenheimer's office, to Intelligence Officer R. A. Taylor, and to Lt. Howard Bush who was trying to keep Trinity base camp running smoothly despite the constantly fluctuating population.

As Bainbridge explained in a somewhat desperate-sounding memo "to all concerned" in April 1945:

"If your schedule is planned some days ahead it will operate to the comfort of all concerned if you tell Lt. Taylor who is going down and when they are going down. Lt. Taylor will notify Lt. Bush, who can then make proper arrangements for sufficient food for the mess. Lt. Bush is issued rations three days a week—Monday, Wednesday and Friday—and he is required on a Monday trip to leave a list of his requirements to be picked up on the following Wednesday trip. This means a minimum of four days notification is necessary if there is to be sufficient food on hand so that he can avoid the present difficulties which late-comers run into of



having to eat delicatessen store meat instead of the particular roast scheduled for that day. Please co-operate . . ."

There were other problems than supply and demand. Sanitary conditions in the mess hall were difficult to maintain because of the hard water. When water softening equipment was installed later it turned out that a miscalculation in water analysis resulted in a unit too small to handle the huge amounts of gypsum and lime encountered.

In the barracks, desert creatures such as scorpions had to be carefully shaken out of clothes each morning before anyone dared dress.

But despite the difficulties the camp ran well. The heat of the desert summer was relieved by swims in the cattle watering reservoirs at the old McDonald ranch. A herd of antelope disappeared from the desert range, a fact which has been attributed by the press to the ravages of the first atomic bomb. Former Trinity residents, however, admit that hunting with submachine guns was a favorite pastime and antelope steak was an almost daily part of the camp menu. So was range beef, lassoed near camp by amateur cowboys. A beer fund maintained by Laboratory people helped make up for the rules against leaving camp and there were nightly outdoor movies supplied from the Army's endless assortment of Hollywood films.

"The choice of Lt. H. C. Bush as commanding officer of the base camp," Bainbridge wrote in 1946, "was a particularly fortunate one. The wise and efficient running of the camp by Lt. Bush contributed greatly to the success of the test. It was a 'happy camp.' The excellent camp morale and military-civilian cooperation did much to ameliorate the difficulties of operation under primitive conditions."

But there were times when the excellent camp morale was put to severe test.

Back in December 1944 Bainbridge had discussed with an unidentified colleague the dangers of a possible overshoot by bombers using the Alamogordo Bombing Range for their practice runs.

"If they should go north of Area No. 3 by mistake in 1945," he wrote, "they would have to go more than 15 miles beyond the boundary in order to interfere with us. The probability that they will overshoot is likely to be very small. Let them have their fun and settle with Ickes for the White Sands National Monument."

But within a few months they were trying to settle with Bainbridge.

The chow line forms at the Base Camp mess hall. Perhaps the menu offers antelope steak.

On May 10 shortly after 1 a.m., three practice 100-pound bombs carrying five-pound black powder flash units were dropped near the Base Camp stables, setting them afire, straddling the main barracks and bringing a poker game to a sudden halt. Three days later another bomb dropped on the carpentry shop. There was no serious damage and no one was hurt.

An investigation revealed that a squadron of bombers from a base some 2500 miles away was on its final long-range practice mission before going overseas. The lead planes had hit and completely obliterated the clearly-marked bombing range targets and in the confusion the following planes assumed the well-lit camp site must be the place.

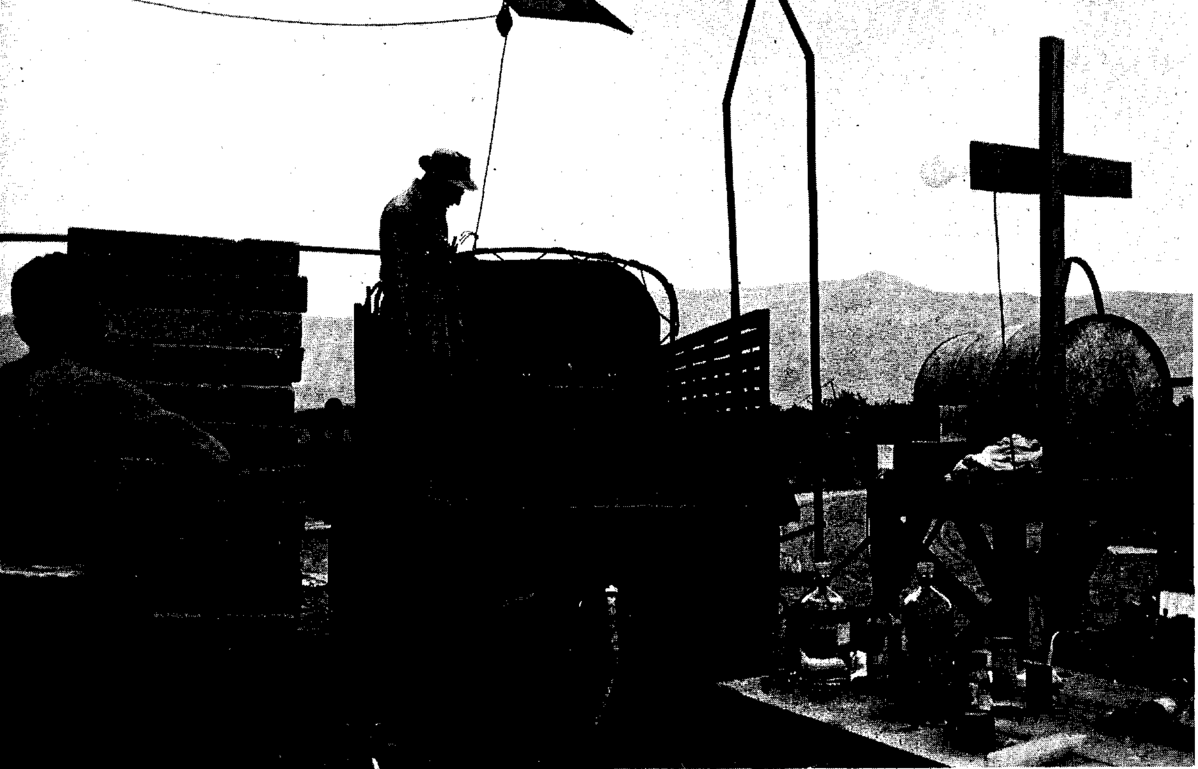
Bainbridge's suggestion that anti-aircraft guns loaded with smoke shells be used to defend the camp was rejected but no further bombing attacks were made.

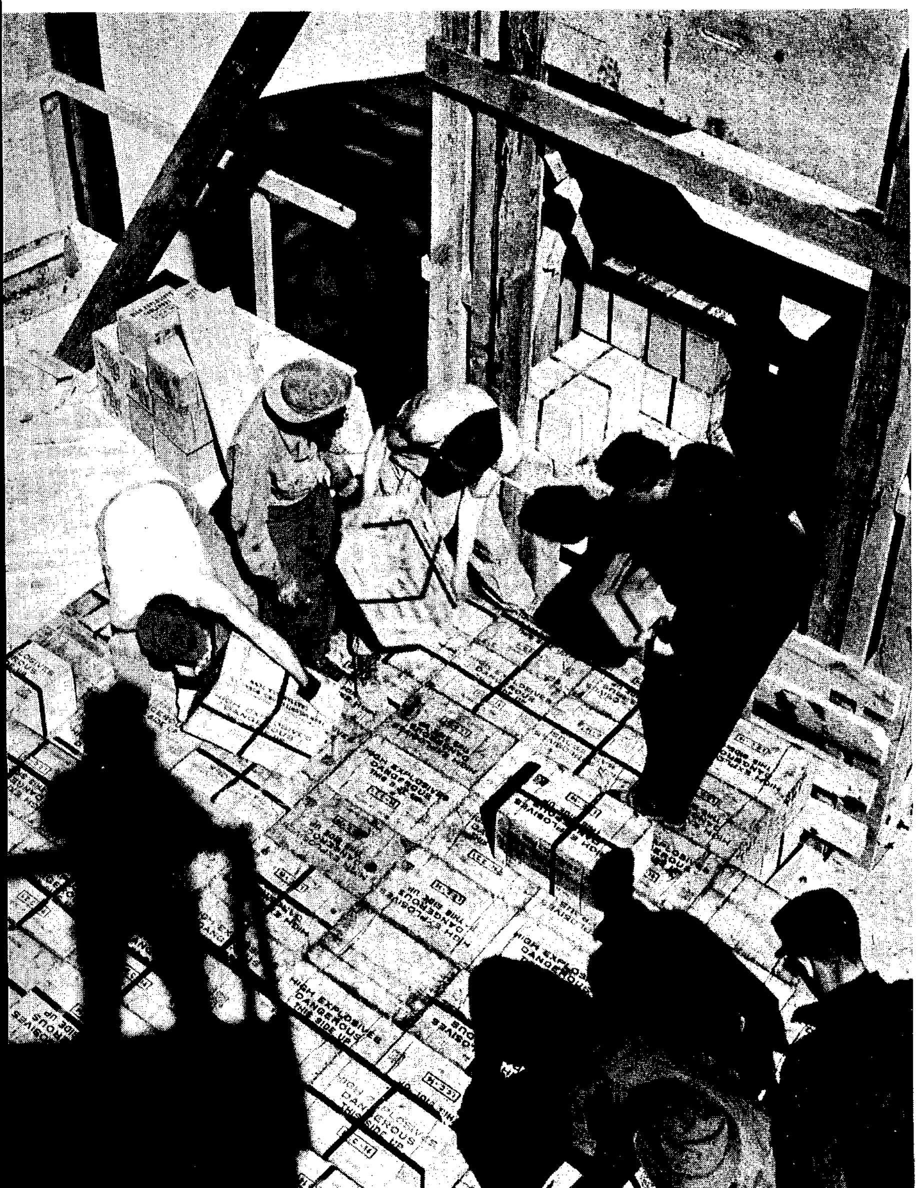
On another occasion, however, a group of electricians working at a distant outpost stomped into camp headquarters, tossed a handful of spent machine gun shells on the CO's desk and resigned. It was soon discovered that gunnery crews in Alamogordo bombers were encouraged to sharpen their trigger eyes on antelope herds roaming the bombing range. For the electricians it had been too close for comfort.

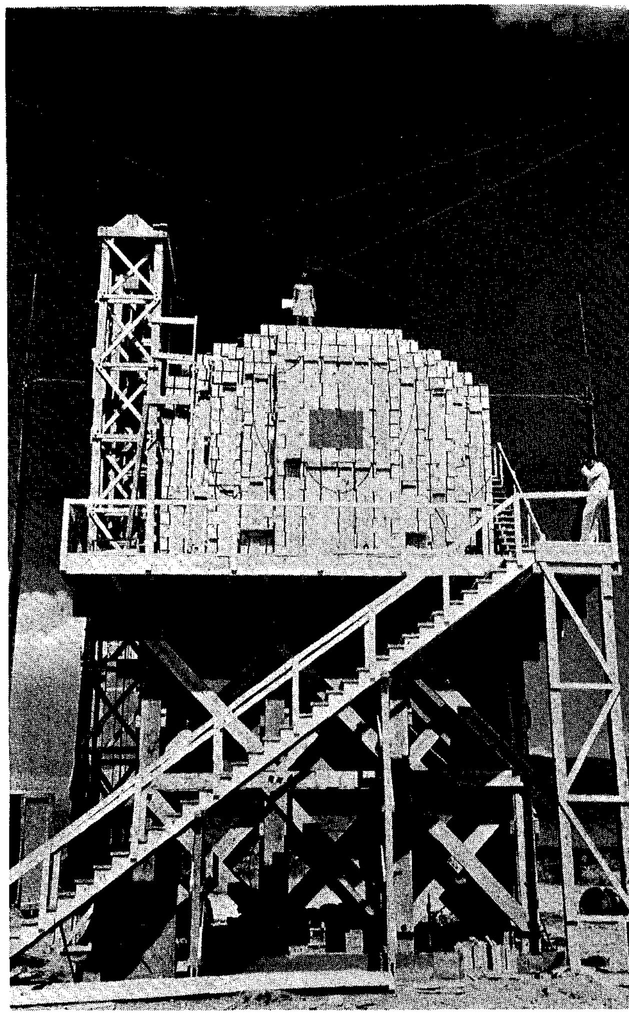
The original date for the trial shot of 100 tons of TNT was May 5 but was soon shifted to May 7 to allow for installation of additional testing equipment. Many additional requests had to be refused since any further delay would have put an intolerable burden on the whole group in its attempt to meet the July test deadline.

Hundreds of crates of high explosive were brought to the site from Fort Wingate, New Mexico, and carefully stacked on the platform of a 20-foot tower. Tubes containing 1000 curies of fission products from the Hanford slug were interspersed in the pile to simulate, at a low level, the radioactive products expected from the nuclear explosion. The whole test was designed in scale for the atomic shot. The center of gravity of the high explosive was in scale with the 100 foot height for the 4,000 to 5,000 tons expected in the final test, and measurements of blast effects, earth shock, and damage to apparatus and apparatus shelters were made at scaled-in distances. Only measurements to determine "cross talk" between circuits and photographic observations were, in general, carried out at the full distance proposed for the final shot.

Then, as the last day of the European war dawned, the TNT was detonated and it was spectacular. A huge, brilliant orange ball rose into the desert sky lighting the pre-dawn darkness as far away as the Alamogordo base 60 miles southeast.




HIGH EXPLOSIVES DANGEROUS THIS SIDE UP



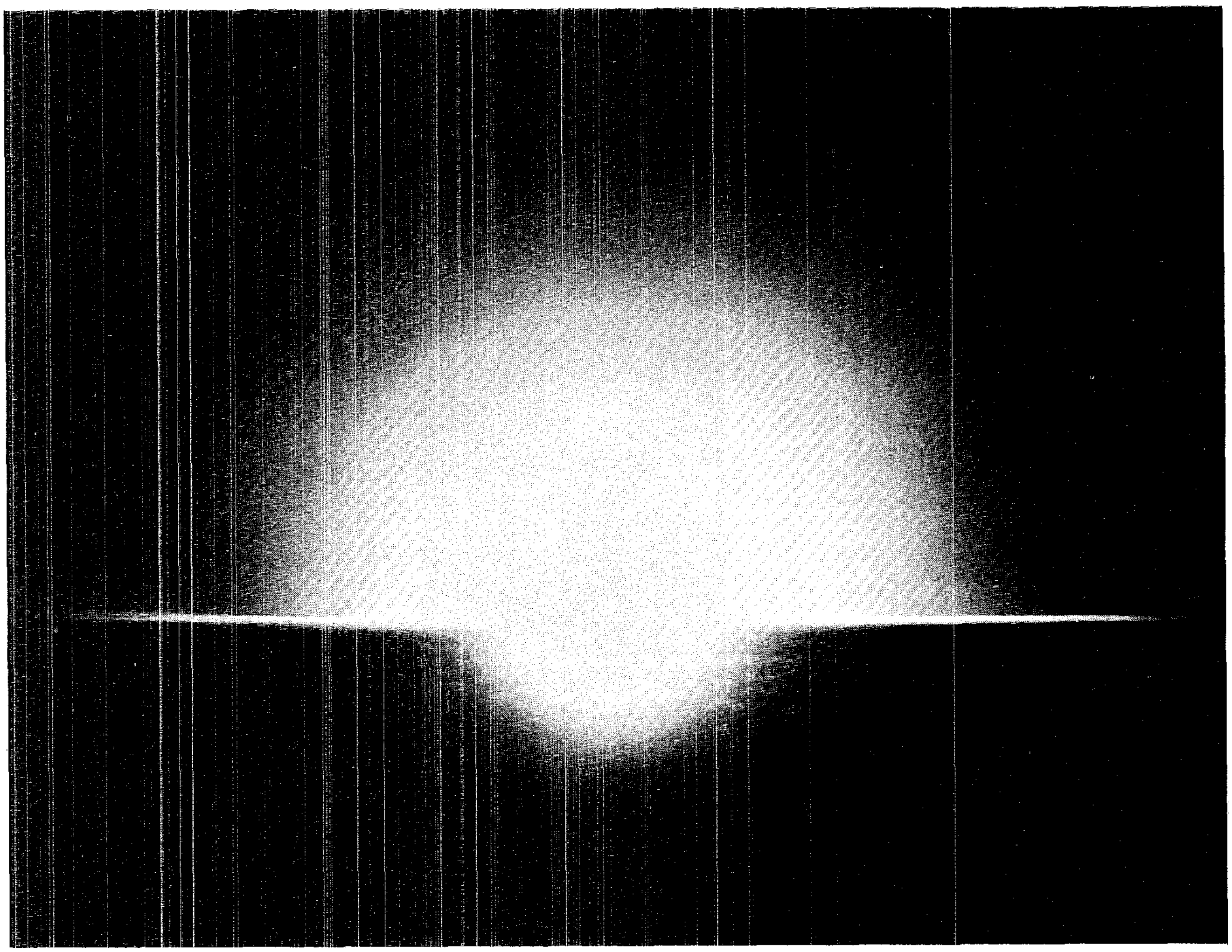
trial run may 7, 1945

A crew prepares fission products from the Hanford slug for insertion in the high explosive for the 100-ton test. Material simulated, at a low level, the radioactive products expected from the nuclear explosion.

Crates of high explosive, brought from Fort Wingate, are stacked on the 20-foot high wooden tower. The men have about 15 more rows to go before the stack will be complete.

Completed stack of 100 tons of TNT rests on the sturdy tower, ready for the May 7 firing. Carpenters who built the tower were appalled, on returning to the site after the test, to find the structure completely obliterated.

The 100-ton explosion would have been an unforgettable sight, witnesses say, had it not been outdone so soon afterwards by the nuclear explosion. Brilliant orange fireball was observed 60 miles away.



The rehearsal proved to be tremendously valuable and the high percentage of successful measurements in the final test may be attributed in large measure to the experience gained from the shot. Blast and earth shock data were valuable not only for calibrating instruments but for providing standards for the safe design of shock proof instrument shelters. Measurement of the effects from the radioactive material inserted in the stack of explosive was especially valuable in giving information on the probable amount and distribution of material which would be deposited on the ground. This information was essential for planning the recovery of equipment, the measurement of bomb efficiency, and protection of personnel for the final shot.

The test also gave the men, accustomed to well-equipped laboratories, a familiarity with the tribulations of field work, and perhaps most importantly, showed up some defects in the test operations while there was still time to correct them.

Immediately after the test Bainbridge asked for lists of complaints about the operations from the various group leaders involved and on May 12, while the experience was still fresh in everyone's minds, held a gripe session to discuss suggestions for improvements.

Far and away the biggest complaint was transportation. Nearly everyone felt there were not enough roads between Ground Zero and the various shelters and the roads that did exist were in intolerable condition. The dust and ruts were hard on both personnel and instruments and the two-wheel drive GI sedans were constantly getting bogged down in a foot or so of soft, loose sand. They also asked for more vehicles and more repair men who could service the cars at night to avoid delays and keep up with the demand.

To overcome poor communications throughout the test site, new phone lines, public address systems to shelters and short wave radios in automobiles were requested as well as a building in which to hold meetings.

Everybody complained of lack of help to get things done on time and asked in particular for more help on procurement, shipping and stock management and a direct teletype to the Los Alamos Procurement Office.

The group felt the operation was severely handicapped by the interminable delays caused by rigid restrictions on the movement of personnel in and out of the various areas just before the test. They asked for and got free access to all parts of the test area during the last few hours before the shot.

Only one man complained about camp food.

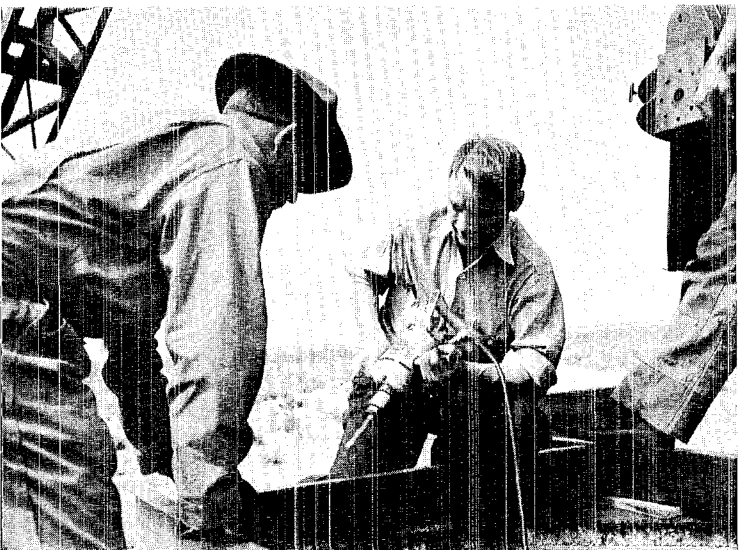
As a result of the meeting, 20 miles of black top road had to be laid, new structures built and a new communication system installed. After the test, too, a major effort had to be devoted to the final timing devices. Each experiment required different time schedules, some having to start ahead of Zero, others requiring a warning pulse only 1000th of a second ahead of the detonation. The circuits were the responsibility of Joseph McKibben and the electronic timing device was developed by Ernest Titterton of Australia. In addition to these chores there were the weak spots pointed out in the trial test to be overcome. And there was precious little time to do it.

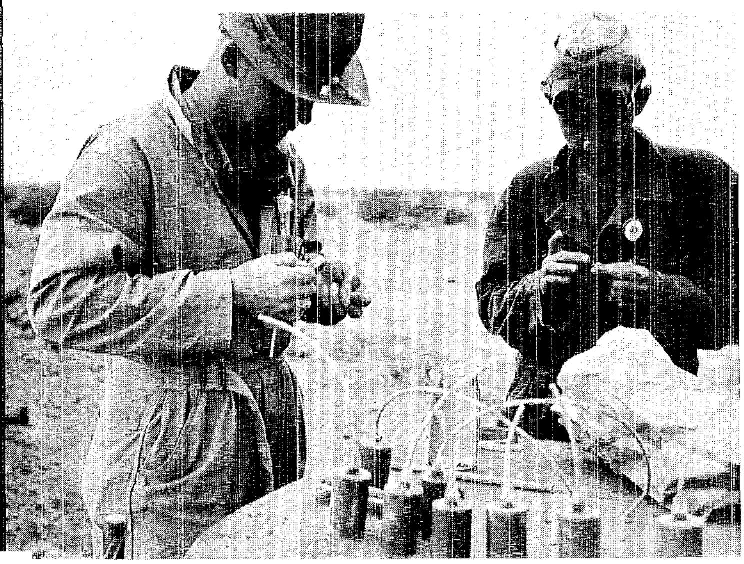
As early as April hopes of meeting the original Independence Day deadline had begun to dim. Delays in the delivery of full scale lens molds and the consequent delay in the development and production of full scale lenses, as well as the tight schedule in production of active material made it necessary to reconsider the date, and on June 9 the Cowpuncher Committee agree that July 13 was the earliest possible date and July 23 was probable.

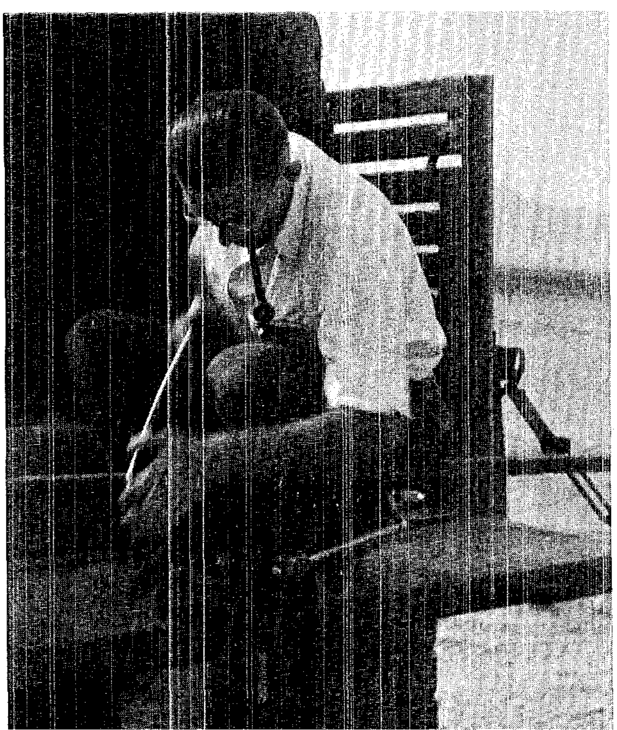
In a memo to all his group leaders on June 19, Oppenheimer explained that although July 4 was accepted as a target date in March, "none of us felt that date could be met." He then announced the Cowpuncher decision and explained, "In reaching this conclusion we are influenced by the fact that we are under great pressure, both internally and externally, to carry out the test and that it undoubtedly will be carried out before all the experiments, tests and improvements that should reasonably be made, can be made."

And so the pressure mounted, security tightened and preparation went on with increasing speed and intensity.

At Trinity the work goes on. Above: Julian Mack and B. C. Benjamin pause for a quick breakfast. Opposite, top: Berlyn Brixner handles a drill in preparation for camera installations at N 10,000. Middle: Benjamin and George Econnomu prepare charges for shock velocity determinations. Bottom: Darol Froman cuts pipe.







countdown

The air hung heavy over the Hill that summer. Rains failed to come and precipitation was half the normal amount. Temperatures rose to average four degrees above normal. Water became scarce and fires threatened, adding to the irritations and frustrations.

Dorothy McKibbin, who ran the Santa Fe liaison office for the Los Alamos project, could discern the tightening of tensions on the Hill, but because of rigid security, she had only her intuition to tell her what was happening. As many as 70 people checked into her office every day and one day she counted 100 phone calls. "The voices on the telephone showed strain and tautness, and I sensed we were about to reach some kind of climax in the project," she recalls.

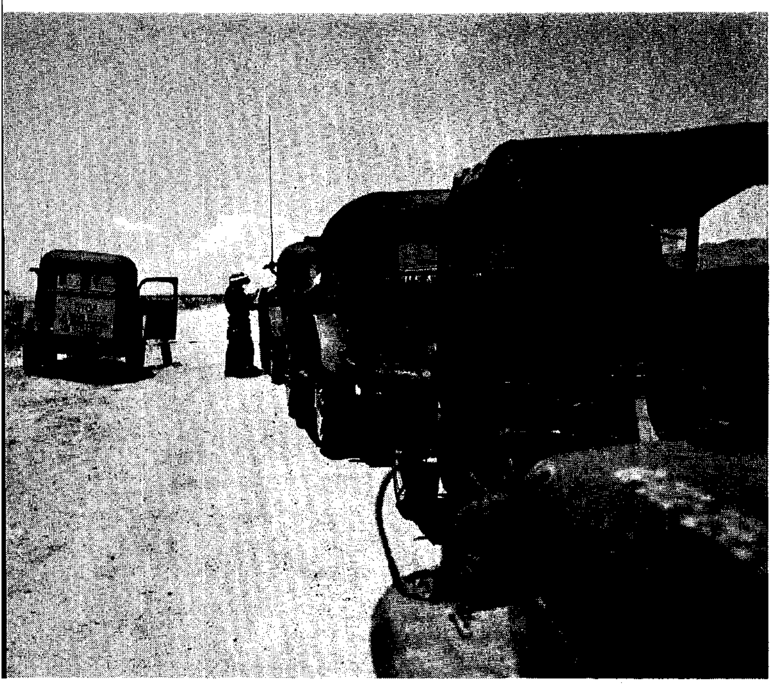
In the Laboratory, one or two hour meetings, attended by consultants, group and section leaders involved in the Trinity Project, were being held every Monday for consideration of new experiments, correlation of the work, detailed scheduling and progress reports.

One of the most important corrective measures resulting from the 100-ton test had been the setting of a date after which further apparatus, particularly electrical equipment, could not be introduced into the experimental area. The deadline would allow plenty of time for dry runs and would reduce the risk of last minute damage to electrical connections. In view of this, proposed experiments were described in writing in great detail and submitted to a special examining committee. If approved they were then submitted to the Monday meetings where they were considered with respect to the test programming as a whole before being accepted. "Any new experiment had to be awfully good to be included after the deadline." Bainbridge reports.

For about a month before the test, John Williams held nightly meetings at Trinity to hear reports on field construction progress and to plan the assignment of men for the following day. Construction help was assigned on the basis of needs and priority of experiments which had been accepted for the test.

Meanwhile, J. M. Hubbard, who had joined the Trinity Project early in April, as meteorology supervisor, had undertaken the job of determining the best test date from a weather point of view.

Weather was a vital factor. Clear weather was best suited to observation planes in the air and visual and photographic measurements on the ground. Rain before or during the test could damage electrical circuits both for firing the gadget and



Guard stations were set up—some in tents, some in trucks—to check the goings and comings of personnel throughout the test site. Movement was restricted; various areas required different badge designations.

operating the instruments. Only six months before the test, according to General Groves, Joseph Hirschfelder, a Los Alamos physicist, had first brought up the possibility that fallout might be a real problem. For this reason it was considered essential that wind direction be such that the radioactive cloud would not pass over inhabited areas that might have to be evacuated, and there should be no rain immediately after the shot which would bring concentrated amounts of fallout down on a small area.

Using reports from each group on the particular weather conditions or surveys they would find most useful and coordinating them with complete worldwide weather information, Hubbard ultimately pinpointed July 18-19 or 20-21 as the ideal date with July 12-14 as second choice. July 16 was mentioned only as a possibility.

However, on June 30 a review of all schedules was made at a Cowpuncher meeting for which all division leaders had submitted the earliest possible date their work could be ready. On the basis of these estimates, July 16 was established as the final date.

From the beginning, estimates of the success of the gadget had been conservative. Although safety provisions were made for yields up to 20,000 tons, test plans were based on yields of 100 to 10,000 tons. By as late as July 10 the most probable yield was set at only 4,000 tons.

Scientists not directly involved in the test established a pool on the yield and the trend was definitely toward the lower numbers, except for Edward Teller's choice of around 45,000 tons. Oppenheimer himself reputedly picked 200 tons and then bet $10 against Kistiakowsky's salary that the gadget wouldn't work at all. (I. I. Rabi, project consultant, won the pool with a guess of 18,000 tons, a number he picked only because all the low numbers had been taken by the time he entered the contest.)

It was not just the yield that was in doubt. Even as the scientists went about the last few weeks of preparations, the nagging uncertainty persisted about whether the bomb would work at all. This air of doubt is depicted in a gloomy parody said to have circulated around the Laboratory in 1945:

"From this crude lab that spawned a dud
Their necks to Truman's axe uncurled
Lo, the embattled savants stood
And fired the flop heard round the world."

Then, as if things weren't looking dismal enough, a meeting of Trinity people held just before the test heard Hans Bethe describe in depressing detail all that was known about the bomb, and all that wasn't. Physicist Frederick Reines remembers the utter dejection he felt after hearing the report. "It seemed as though we didn't know anything," he said.

It was only natural, Bethe wrote later, that the scientists would feel some doubts about whether the bomb would really work. They were plagued by so many questions: Had everything been done right? Was even the principle right? Was there any slip in a minor point which had been overlooked? They would never be sure until July 16.

By the first week in July, plans were essentially complete and the hectic two weeks that remained were devoted to receiving and installing equipment, completing construction, conducting the necessary tests and dry runs and, finally, assembling the device.

The plans, as described in the official AEC history, "The New World," were these:

"Working in shelters at three stations 10,000 yards south, west and north of the firing point, teams of scientists would undertake to observe and measure the sequence of events. The first task was to determine the character of the implosion. Kenneth Greisen and Ernest Titterton would determine the interval between the firing of the first and last detonators. This would reveal the degree of simultaneity achieved. Darol Froman and Robert R. Wilson would calculate the time interval between the action of the detonators and the reception of the first gamma rays coming from the nuclear reaction. From this value they hoped to draw conclusions as to the behavior of the implosion. With Bruno Rossi's assistance, Wilson would also gauge the rate at which fissions occurred.

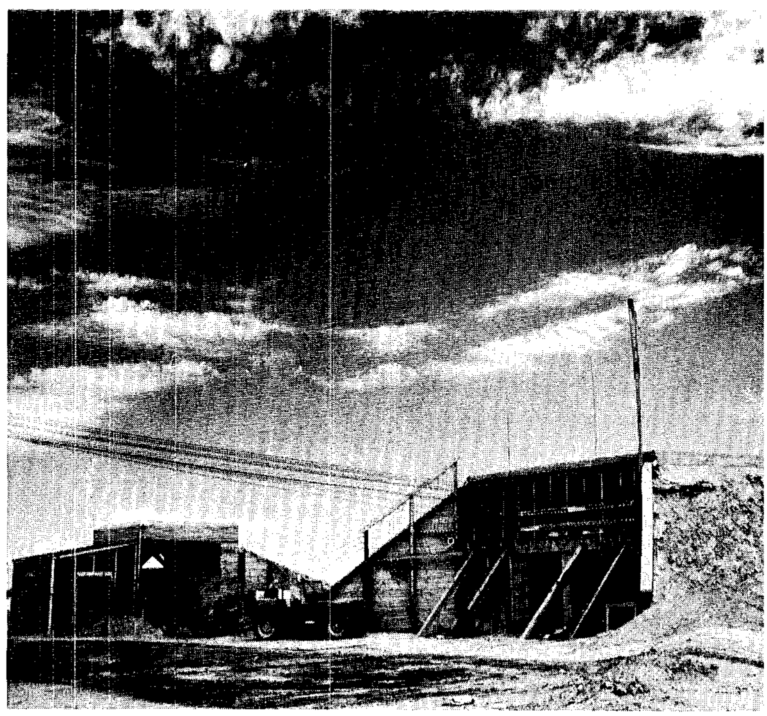
"Implosion studies were only a start. The second objective was to determine how well the bomb accomplished its main objective—the release of nuclear energy. Emilio Segre would check the intensity of the gamma rays emitted by the fission products, while Hugh T. Richards would investigate the delayed neutrons. Herbert L. Anderson would undertake a radiochemical analysis of soil in the neighborhood of the explosion to determine the ratio of fission products to unconverted plutonium. No one of these methods was certain to provide accurate results, but the interpretation of the combined data might be very important.

"The third great job at Trinity was damage measurements. John H. Manley would supervise a series of ingenious arrangements to record blast pressure. Others would register earth shock while William G. Penney would observe the effect of radiant heating in igniting structural materials. In addition to these specific research targets, it was important to study the more general phenomena. This was the responsibility of Julian E. Mack. His group would use photographic and spectrographic observations to record the behavior of the ball of fire and its aftereffects." Some cameras would take color motion pictures, some would take black and white at ordinary speeds and others would be used at exceedingly high speeds, up to 8000 frames per second, in order to catch the very beginning of the blast wave in the air. There also would be several spectrographs to observe the color and spectrum of the light emitted by the ball of fire in the center of the blast.

Observation planes, one of them carrying Capt. Parsons, head of the overseas delivery project, would fly out of Albuquerque making passes over the test site to simulate the dropping of a bomb. They would also drop parachute-suspended pressure gauges near Ground Zero. One of the main reasons for the planes would be to enable Parsons to report later on the relative visual intensity of the explosion of the test bomb and that of the bomb to be dropped on Japan.

Plans also were made to cover the legal and safety aspects of the test.

To protect men and instruments, the observation shelters would be located 10,000 yards from Ground Zero and built of wood with walls reinforced with concrete and buried under huge layers of earth. Each shelter was to be under the supervision of a scientist until the shot was fired at which time a medical doctor would assume leadership. The medics were familiar with radiation and radiation instruments and would be responsible for efficient



Station South 10,000 served as the main control point for the Trinity test. Robert Oppenheimer, Bainbridge and General Farrell were among those who watched the explosion from this bunker.

McDonald ranch, used for final assembly of the active material, still stands at Trinity.

evacuation of the shelters on designated escape routes in case of emergency. Vehicles would be standing by ready to leave on a moments notice, manned by drivers familiar with the desert roads at night. Commanding the shelters would be R. R. Wilson and Dr. Henry Barnett at N 10,000, John Manley and Dr. Jim Nolan at W 10,000 and Frank Oppenheimer and Dr. Louis Hemplemann at S 10,000.

A contingent of 160 enlisted men under the command of Major T. O. Palmer were to be stationed north of the test area with enough vehicles to evacuate ranches and towns if it became necessary and at least 20 men with Military Intelligence were located in neighboring towns and cities up to 100 miles away serving a dual purpose by carrying recording barographs in order to get permanent records of the blast and earth shock at remote points for legal purposes.

On July 5, just six days after enough plutonium had been released, Oppenheimer wired Project consultants Arthur H. Compton in Chicago and E. O. Lawrence in Berkeley:

"Anytime after the 15th would be a good time for our fishing trip. Because we are not certain of the weather we may be delayed several days. As we do not have enough sleeping bags to go around, we ask you please not to bring any one with you."

There wasn't much sleeping being done anywhere at Trinity those last frantic days. There were about 250 men from Los Alamos at the test site doing last minute technical work and many more were in Los Alamos contributing to the theoretical and experimental studies and in the construction of equipment. And all of them were working against time.

"The Los Alamos staff was a dedicated group," John Williams is quoted as saying some years later. "It was not uncommon to have a 24 hour work day at the end."

On July 1 the final schedule was broadcast at Trinity and circulated around the camp two days later. Rehearsals would be held July 11, 12, 13 and 14. Originally scheduled to be held in the afternoon, the times were changed after the first dry run when daily afternoon thunderstorms began to interfere with the flight of the observation planes and to produce electrical interference and pick up on the lines.

Meanwhile, Norris Bradbury, group leader for bomb assembly, had issued his countdown. Beginning on July 7 in Los Alamos the high explosive components were put through a number of tests to study methods of loading and the effects of transportation and a dry run on the assembly. On July 10 the crew began the tedious round-the-clock preparations of the components for delivery to Trinity, using night shifts to get the job done. Thursday, July 12, assembly began at V site and by late that night they were ready to "seal up all holes in the case; wrap with scotch tape (time not available for strippable plastic), and start loading on truck."

At 1 a.m. on Friday, July 13, the pre-assembled high explosive components started for Trinity in a truck convoyed by Army Intelligence cars in front and behind with George Kistiakowsky accompanying the precious cargo in the forward car.

The two hemispheres of plutonium made the trip to Trinity from Los Alamos on July 11, accompanied by a Lt. Richardson and several soldiers in a convoyed sedan and delivered to Bainbridge at the tower. A receipt for the plutonium was requested.

"I was very busy and we were fighting against time," Bainbridge recalled recently. "I thought 'What kind of foolishness is this,' and directed the men to the assembly site at McDonald ranch."

Bainbridge remembers that Richardson and his crew seemed awfully eager to get rid of their strange cargo even though they weren't supposed to know the real significance of it.

Eventually the receipt was signed at the ranch by Brig. Gen. T. F. Farrell, Groves deputy, and handed to Louis Slotin who was working on nuclear assembly. The acceptance of the receipt signaled the formal transfer of the precious Pu-239 from the Los Alamos scientists to the Army for use in a test explosion.

Nuclear tests and the assembly of the active components were completed at the ranch and shortly after noon on Friday the 13th final assembly of the bomb began in a canvas tent at the base of the tower.

Bradbury's detailed step-by-step instructions for the assembly process, which was interrupted at frequent intervals for "inspection by generally interested personnel," show the careful, gingerly fashion in which the crew approached its history-making job.

"Pick up GENTLY with hook."

"Plug hole is covered with a CLEAN cloth."

"Place hypodermic needle IN RIGHT PLACE. Check this carefully."

"Insert HE—to be done as slowly as the G (Gadget) engineers wish. . . . Be sure shoe horn is on hand."

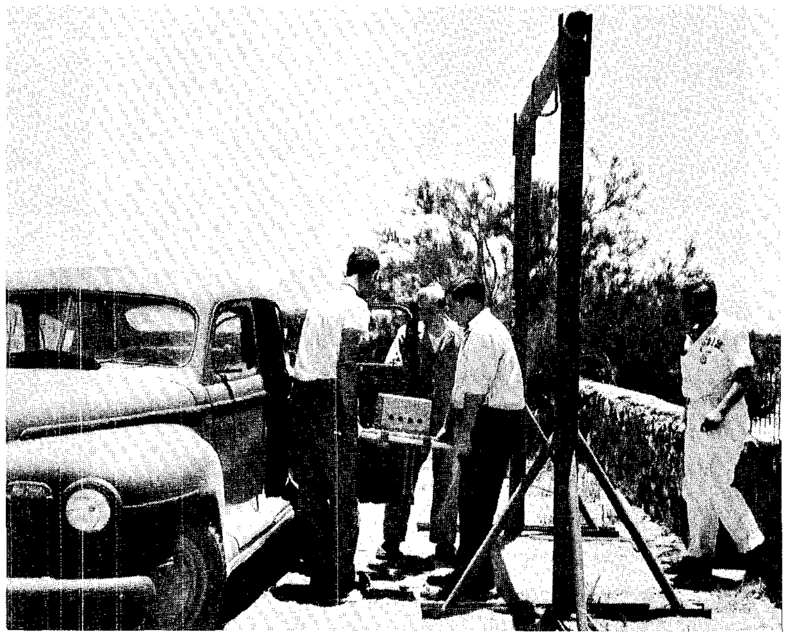
"Sphere will be left overnight, cap up, in a small dish pan."

By late afternoon the active material and the high explosive came together for the first time.

Neither Bradbury nor Raemer Schreiber, a member of the pit assembly crew, remembers any particular feeling of tension or apprehension during the operation although, Bradbury said, "There is always a certain amount of concern when you are working with high explosives."

"We were given plenty of time for the assembly of active material," Schreiber remembers. "By then it was pretty much a routine operation. It was simply a matter of working very slowly and carefully, checking and re-checking everything as we went along."

The assembly departed from the routine only once, when the crew made the startling discovery that the two principal parts of the gadget, carefully designed and precision machined, no longer fit together. Marshall Holloway, in charge of pit assembly, came to the rescue and in only a couple of minutes had the problem solved.



Active material for the Trinity device is moved from the sedan that brought it to McDonald ranch.

Initiators for the gadget are delivered to the McDonald ranch assembly room in a shock-proof case.

The plutonium component, which had generated a considerable amount of its own heat during the trip from Los Alamos, had expanded. The other section of the assembly had remained cold. The heat exchange resulting when the hot material was left in contact with the cold for only a minute or two soon had the two pieces slipping perfectly together.

Early the next morning the tent was removed and the assembled gadget was raised to the top of the 100-foot tower where it rested in a specially constructed sheet steel house. But it was still without detonators.

"Detonators were very fragile things in those days," Bradbury explained. "We didn't want to haul that gadget around with the detonators already in it. We might have dropped it."

So it was up to the detonator crew, headed by Kenneth Greisen, to climb the tower and make the final installations and inspections and to return every six hours to withdraw the manganese wire whose induced radioactivity was a measure of neutron background. The necessary cables were connected to a dummy unit which would permit tests to continue while the bomb was armed.

Late that night the job was essentially complete. The gadget was left in the care of an armed guard and the scientists and technicians were left with only the final routine preparations and last-minute adjustments on their equipment.

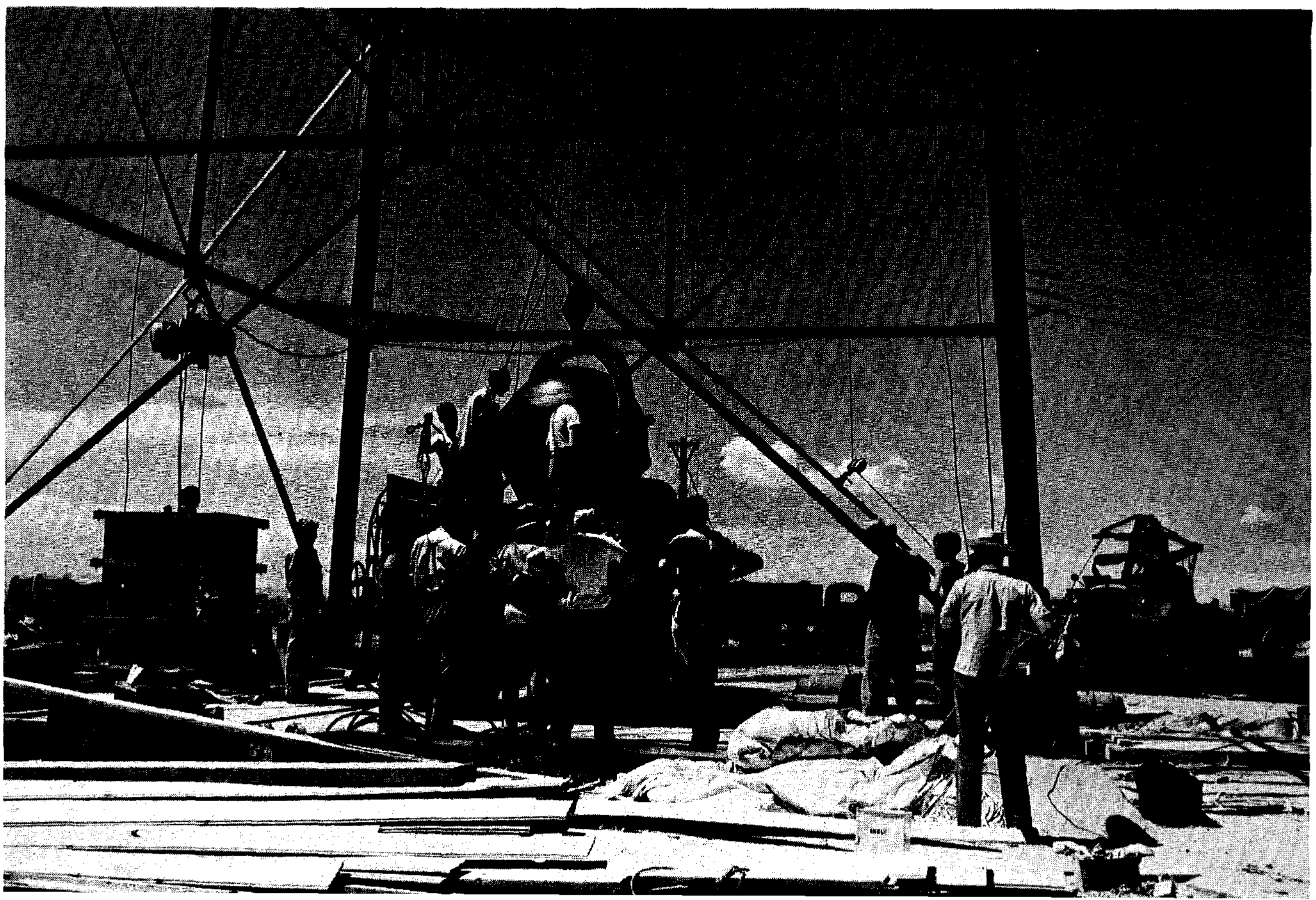
All planes at the Alamogordo base were grounded until further notice and arrangements had been made with the Civil Aeronautics Authority, the Air Corps and Navy to insure that the entire area would be barred to all aircraft during the last important hours.

According to General Groves, it was quite upsetting to the base, for it was there that B-29 crews received their final training before leaving for the Pacific and every unit commander wanted his crew to have as many hours in the air as possible. All they knew was that their training schedules were being upset for some unexplained reason. Many men, Groves continued, were already on the landing field when the explosion occurred and not long after several thousand men were preparing for take-offs.

Meanwhile, the high-ranking observers began to assemble. On Sunday afternoon General Groves, who had been touring Manhattan District installations on the West Coast in order to be nearby in case the test hour was advanced, arrived at Trinity with Vannevar Bush and James B. Conant, members of the MED's policy committee. A busload of consultants from Project Y left Los Alamos for the desert and automobiles were dispatched to Santa Fe to pick up Charles A. Thomas, MED's coordinator for chemical research, and to Albuquerque for Ernest O. Lawrence, Sir James Chadwick and William L. Laurence of the New York *Times*, the one newsman assigned by the Manhattan District to document the development of the bomb.

At the test site, after months of hectic activity, things became more relaxed as the final items on Bradbury's hot run countdown indicate:

Sunday, 15 July, all day: Look for rabbit's feet and four-leafed clovers. Should we have the chaplain



down there? Period for inspection available from 0900-1000.

Monday, 16 July, 0400: BANG!

But it wasn't quite as simple as that. By Sunday evening the skies had darkened, thunder rolled in the surrounding mountains and lightning cracked through the overcast. It began to rain. Now that the test was ready, at long last, could it actually go?

Shortly before 11 p.m. Sunday night the arming party, consisting of Bainbridge, Kistiakowsky, Joe McKibben, two Army weathermen, Lt. Bush and a guard, assembled at the base camp for the final trip to the tower.

McKibben, who had the very important and punishing job of supplying the timing and remote operating signals, was dead tired. "He had had a more trying time for two weeks than most of us," Bainbridge recalled. "Any one of 50 people with special test equipment who needed timing and activating signals over their control wires had been asking McKibben and his group for rehearsals at all hours of the day and night for two weeks with very large amounts of business the week prior to July 16."

But tired or not, McKibben had with him a two-page check list of 47 jobs to be done before Zero hour. His preliminary jobs were finished by 11 and he was urged to get some sleep. "I remember he looked absolutely white with fatigue," Bainbridge said, "and we wanted him alert and ready at test time."

Donald Hornig came out, went to the top of the tower to switch the detonating circuit from the dummy practice circuit to the real gadget and then returned to S 10,000 where he would be responsible for the "stop" switch. If anything went wrong while the automatic devices were operating seconds before the detonation, he would pull the switch and prevent the explosion.

Kistiakowsky climbed about 30 feet up the tower to adjust a light at the radioed request of a cameraman and then returned to the car to sleep. Periodically Lt. Bush or the guard turned their flashlights on the tower to make certain there was no one trying to interfere with the cables. Hubbard and his assistants continued with their weather measurements while Bainbridge kept in touch with John Williams on the land telephone at S 10,000.

"It was raining so hard," McKibben remembers, "I dreamed Kisti was turning a hose on me." There was lightning, too, but not dangerously close to the tower. The rain continued. Back at the control dugout Oppenheimer and General Groves consulted through the night.

On July 14 the tent was removed and the device, completely assembled except for the detonators, was raised to the top of the 100-foot tower.

"Every five or ten minutes Oppenheimer and I would go outside and discuss the weather," Groves writes. "I was shielding him from the excitement swirling about us so that he could consider the situation as calmly as possible."

Fortunately, Groves continues, "although there was an air of excitement at the dugout, there was a minimum of conflicting advice and opinions because everyone there had something to do, checking and re-checking the equipment under their control."

At 1 a.m. Groves urged the director to get some sleep. Groves himself joined Bush and Conant in a nearby tent for a quick nap without much luck. "The tent was badly set up," Groves recalls, "and the canvas slapped constantly in the high wind."

By 2 a.m. the weather began to look better and it was decided that the shot probably could be fired that morning, but instead of the planned hour of 4 a.m. it was postponed until 5:30. The waiting and checking continued.

The rain stopped at 4:00 a.m. At 4:45 a.m. the crucial weather report came: "Winds aloft very light, variable to 40,000 surface calm. Inversion about 17,000 ft. Humidity 12,000 to 18,000 above 80%. Conditions holding for next two hours. Sky now broken becoming scattered." The wind directions and velocities at all levels to 30,000 feet looked good from a safety standpoint. Bainbridge and Hubbard consulted with Oppenheimer and General Farrell through Williams on the telephone. One dissenting vote could have called off the test. The decision was made. The shot would go at 5:30.

The arming party went into action. Bainbridge, McKibben and Kistiakowsky drove with Lt. Bush to the west 900 yard point where, according to McKibben's check list, he "opened all customer circuits." Back at the tower connections were checked, switches were thrown and arming, power, firing and informer leads were connected. Bainbridge kept in touch with Williams by phone, reporting each step before it was taken.

"In case anything went sour," Bainbridge explained, "the S 10,000 group would know what had messed it up and the same mistake could be avoided in the future."

The lights were switched on at the tower to direct the B-29s and the arming party headed for the control point at S 10,000, driving, they all insist, at the reasonable rate of about 25 miles an hour.

Arriving at S 10,000 about 5 a.m. Bainbridge broadcast the weather conditions so that leaders at the observation points would have the latest information and know what to worry about in the way of fallout.

Ready for the countdown, the first atomic device waits in its steel shelter at the top of the tower. Opposite page: The formation of the fireball during the first four seconds after detonation.

Then from Kirtland Air Force Base came word from Captain Parsons. Weather was bad at Albuquerque and the base commander did not want the plane to take off. But the decision was already made.

Later the planes did take off but because of overcast only fleeting glimpses of the ground could be seen and Parsons was barely able to keep the plane oriented. Unable to drop their gauges with any degree of accuracy the airborne group became merely observers.

Just after 5 Bainbridge used his special key to unlock the lock that protected the switches from tampering while the arming party was at the tower. At 5:10 a.m. Sam Allison began the countdown.

All through the night the spectators had been gathering to await the most spectacular dawn the world had ever seen.

They waited on high ground outside the control bunker. They waited at the observation posts at West and North 10,000. They waited in arroyos and in surrounding hills. A group of guards waited in slit trenches in Mockingbird Gap between Oscuro and Little Burro Peaks.

All had been instructed to lie face down on the ground with their feet toward the blast, to close their eyes and cover them as the countdown approached zero. As soon as they became aware of the flash they could turn over and watch through the darkened glass that had been supplied.

On Compagna Hill, 20 miles northwest of Ground Zero, a large contingent of scientists waited along with Laurence of the *Times*. They shivered in the cold and listened to instructions read by flashlight by David Dow, in charge of that observation post. They ate a picnic breakfast. Edward Teller warned about sunburn and somebody passed around some sunburn lotion in the pitch darkness.

Fred Reines, a former Los Alamos physicist, waited with Greisen and I. I. Rabi, a project consultant, and heard the "Voice of America" burst forth on the short wave radio with "Star Spangled Banner" as if anticipating a momentous event.

Al and Elizabeth Graves, a husband and wife scientific team, waited in a dingy Carrizozo motel with their recording instruments. Others, mostly military men, waited at spots as far away as 200 miles, their instruments ready to record the phenomena.

In San Antonio, Restaurant Proprietor Jose Miera was awakened by the soldiers stationed at his place with seismographs. "If you come out in front of your store now, you'll see something the world has never seen before," they told him.

Just south of San Antonio, a group of hardy Los Alamos souls, who had climbed into the saddle of Chupadero Peak the day before, waited drowsily in their sleeping bags.

In Los Alamos, most people slept but some knew and went out to watch from the porches of their Sundt apartments. Others drove into the mountains for a better view. Mr. and Mrs. Darol Froman and a group of friends waited in their car, gave up and were heading back down the mountain when 5:30 came.

A group of wives, whose husbands had been off in the desert for endless weeks, waited in the chill air of Sawyer's Hill. Months later one of them described the agonizing hours.

"Four o'clock. Nothing was happening. Perhaps something was amiss down there in the desert where one's husband stood with other men to midwife the birth of the monster. Four fifteen and nothing yet. Maybe it had failed. At least, then, the husbands were safe. . . . Four thirty. The gray dawn rising in the east, and still no sign that the labor and struggle of the past three years had meant anything at all. . . . It hardly seemed worthwhile to stand there, scanning the sky, cold and so afraid."

Elsewhere the world slept or fought its war and President Truman waited at Potsdam.

Back at Trinity, over the intercoms, the FM radios, the public address system, Sam Allison's voice went on, counting first at five-minute intervals then in interminable seconds.

"Aren't you nervous?" Rabi asked Greisen as they lay face down on the ground.

"Nope," replied Greisen.

"As we approached the final minute," Groves wrote, "the quiet grew more intense. I was on the ground (at Base Camp) between Bush and Conant. As I lay there in the final seconds, I thought only of what I would do if the countdown got to zero and nothing happened."

Conant said he never knew seconds could be so long.

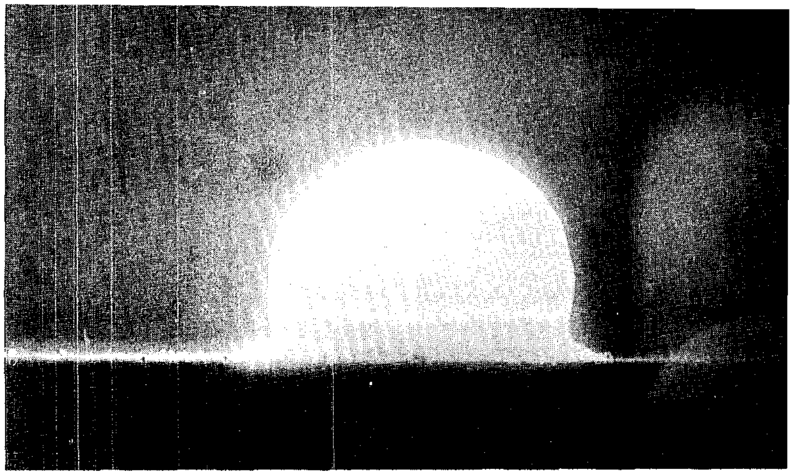
At the control point, General Farrell wrote later, "The scene inside the shelter was dramatic beyond words. . . . It can be safely said that most everyone present was praying. Oppenheimer grew tenser as the seconds ticked off. He scarcely breathed. He held on to a post to steady himself."

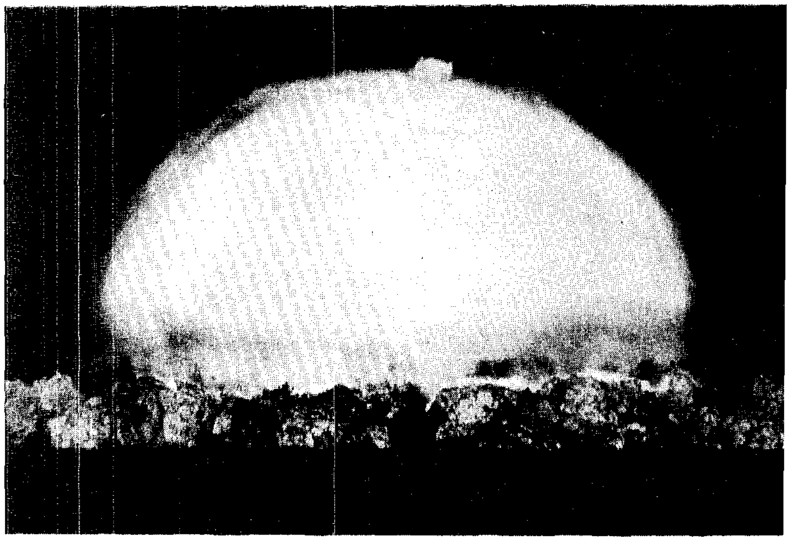
The countdown went on. At minus 45 seconds Joe McKibben threw the switch that started the precise automatic timer. Now it was out of man's control, except for Hornig who watched at his post at the stop switch.

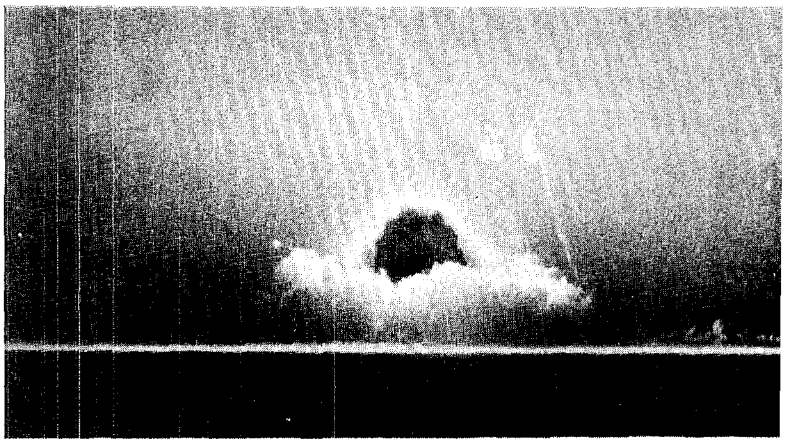
Minus 30 seconds, and Williams and Bainbridge joined the others outside the control dugout.

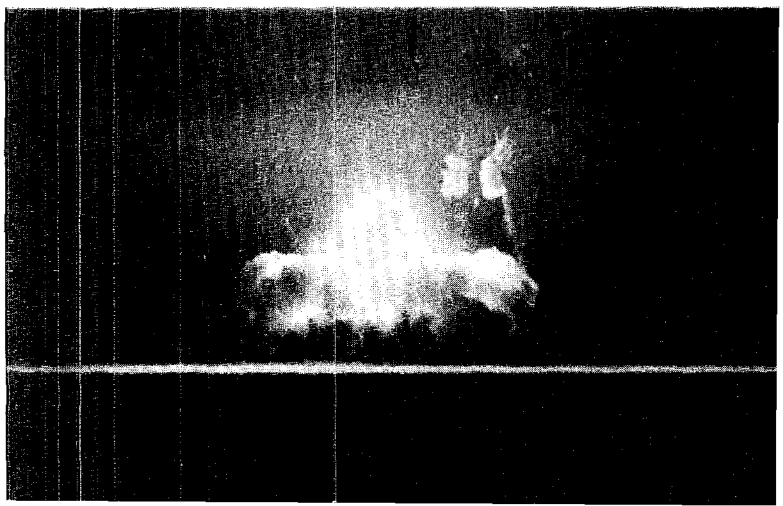
Minus 10 seconds. Cool-headed Greisen changed his mind. "Now I'm scared," he suddenly blurted to Rabi.

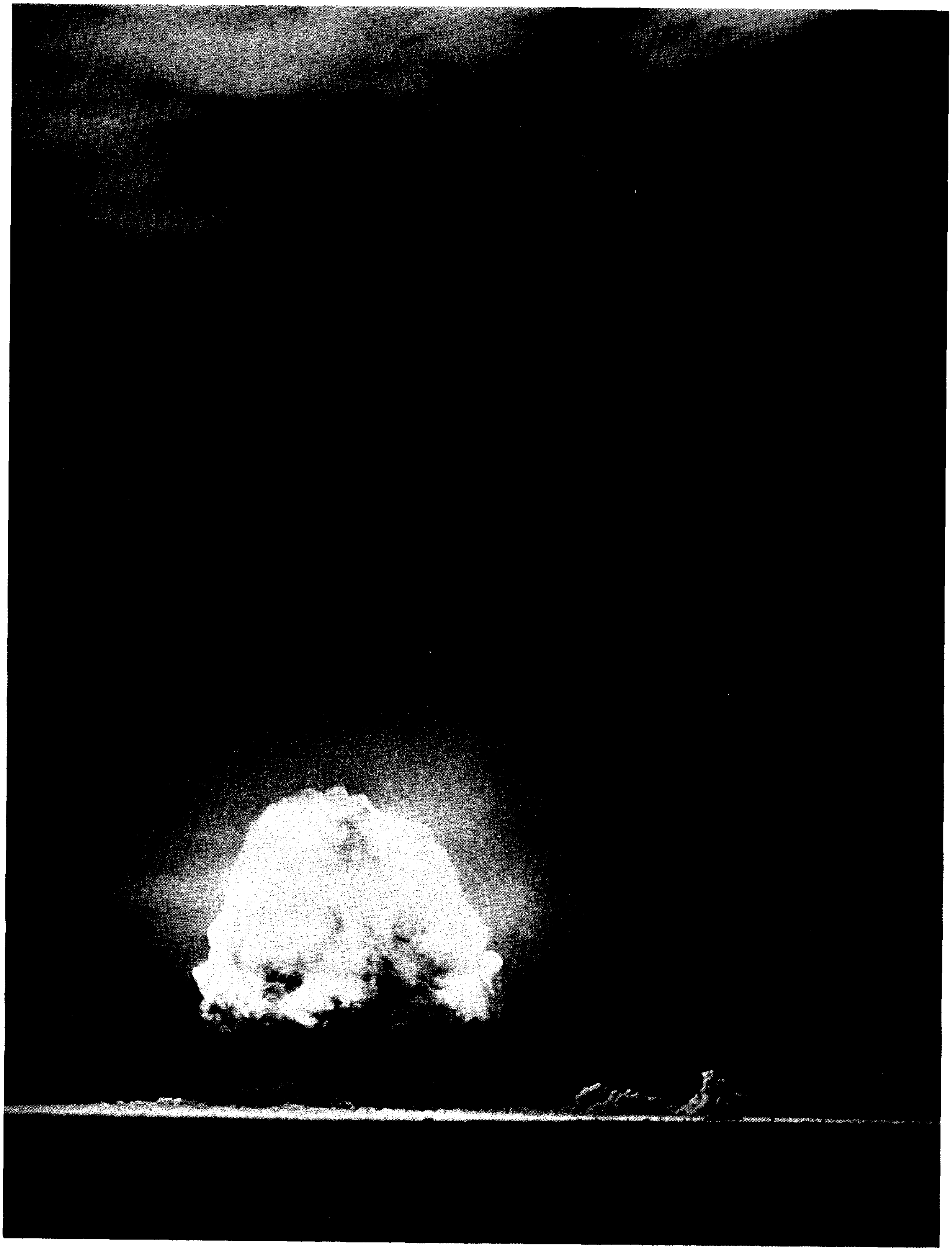
Then, as the world teetered on the brink of a new age, Sam Allison's voice cried, "Now!"











the new world

At that instant—5:29:45 a.m. Mountain War Time on July 16, 1945—came an incredible burst of light, bathing the surrounding mountains in an unearthly brilliance. Then came the shock wave that knocked over two men at S 10,000, then the thunderous roar. A vast multi-colored cloud surged and billowed upward. The steel tower that held the bomb vanished, the tower that held Jumbo, 800 feet away, lay crumpled and broken on the ground.

Wrote Enrico Fermi shortly after the test:

"My first impression of the explosion was the very intense flash of light, and a sensation of heat on the parts of my body that were exposed. Although I did not look directly towards the object, I had the impression that suddenly the countryside became brighter than in full daylight. I subsequently looked in the direction of the explosion through the dark glass and could see something that looked like a conglomeration of flames that promptly started rising. After a few seconds the rising flames lost their brightness and appeared as a huge pillar of smoke with an expanded head like a gigantic mushroom that rose rapidly beyond the clouds, probably to a height of the order of 30,000 feet. After reaching full height, the smoke stayed stationary for a while before the wind started dispersing it."

Fermi then went on to explain the simple experiment he took time to conduct that helped considerably in making the first early estimates of the bomb's success.

"About 40 seconds after the explosion the air blast reached me. I tried to estimate its strength by dropping from about six feet small pieces of paper before, during and after the passage of the blast wave. Since, at the time, there was no wind, I could observe very distinctly and actually measure the displacement of the pieces of paper that were in the process of falling while the blast was passing. The shift was about two and a half meters, which at the time, I estimated to correspond to the blast that would be produced by ten thousand tons of TNT."

Hans Bethe wrote that "it looked like a giant magnesium flare which kept on for what seemed a whole minute but was actually one or two seconds. The white ball grew and after a few seconds became clouded with dust whipped up by the explosion from the ground and rose and left behind a black trail of dust particles. The rise, though it seemed slow, took place at a velocity of 120 meters per second. After more than half a minute the flame died down and the ball, which had been a brilliant white became a dull purple. It continued to rise and spread at the same time, and finally broke through and rose above the clouds which were 15,000 feet above the ground. It could be distinguished from the clouds by its color and could be followed to a height of 40,000 feet above the ground."

Joe McKibben recalls that "we had a lot of flood lights on for taking movies of the control panel. When the bomb went off, the lights were drowned out by the big light coming in through the open door in the back."

"After I threw my last switch I ran out to take a look and realized the shock wave hadn't arrived yet. I ducked behind an earth mound. Even then I had the impression that this thing had gone really big. It was just terrific."

"The shot was truly awe-inspiring," Bradbury has said. "Most experiences in life can be comprehended by prior experiences but the atom bomb did not fit into any preconception possessed by anybody. The most startling feature was the intense light."

Bainbridge has said that the light was the one place where theoretical calculations had been off by a big factor. "Much more light was produced than had been anticipated."

A military man is reported to have exclaimed, "The long-hairs have let it get away from them!"

While scientists were able to describe the technical aspects of the explosion, for others it was more difficult.

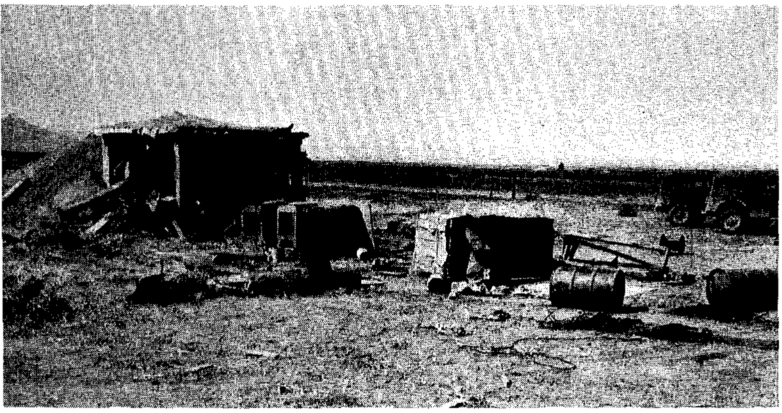
"Words are inadequate tools for acquainting those not present with the physical, mental and psychological effects. It had to be witnessed to be realized," wrote General Farrell two days later. Nonetheless, many tried to describe the historic moment.

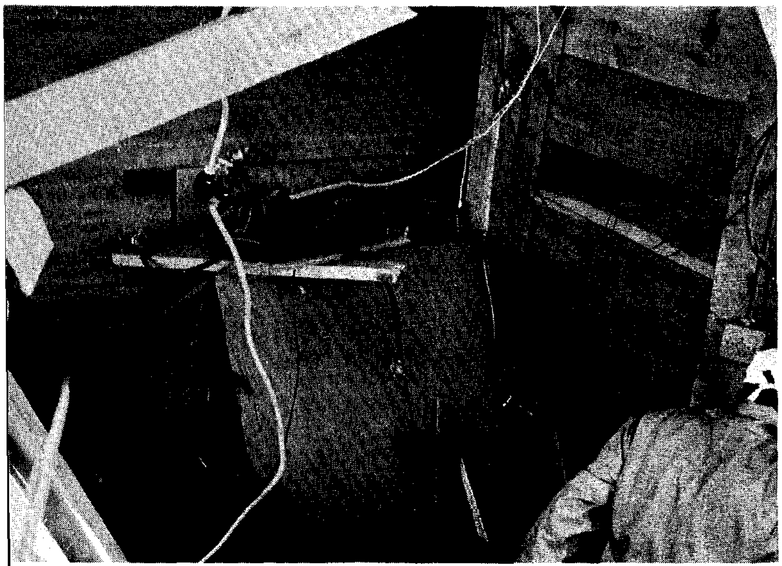
Farrell himself wrote:

"The effects could well be called unprecedented, magnificient, beautiful, stupendous, and terrifying. No man-made phenomenon of such tremendous power had ever occurred before. The lighting effects beggared description. The whole country was lighted by a searing light with the intensity many times that of the midday sun. It was golden, purple, violet, gray and blue. It lighted every peak, crevasse and ridge of the nearby mountain range with a clarity and beauty that cannot be described but must be seen to be imagined. Seconds after the explosion came, first, the air blast pressing hard against the people, to be followed almost immediately by the strong, sustained awesome roar which warned of doomsday and made us feel we puny things were blasphemous to dare tamper with the forces heretofore reserved for the Almighty."

William L. Laurence, whose sole job was to write down the moment for history, wrote:

"It was like the grand finale of a mighty symphony of the elements, fascinating and terrifying, uplifting





Damage to the instrument shelter at North 1000 is shown in the two top photos. At the bottom, Jumbo stands unscathed, its tower crumpled around it.

and crushing, ominous, devastating, full of great promise and great foreboding."

Another time he said, "On that moment hung eternity. Time stood still. Space contracted to a pinpoint. It was as though the earth had opened and the skies split. One felt as though he had been privileged to witness the Birth of the World—to be present at the moment of Creation when the Lord said: Let there be light."

Oppenheimer, on the other hand, has said he was reminded of the ancient Hindu quotation:

"I am become Death, the destroyer of worlds."

At the time, however, probably few actually thought of the consequences of their work, beyond ending the war. Bradbury said recently, "For that first 15 seconds the sight was so incredible that the spectators could only gape at it in dumb amazement. I don't believe at that moment anyone said to himself, 'What have we done to civilization?' Feelings of conscience may have come later."

Bainbridge reports that his reactions were mixed. "When the bomb first went off I had the same feelings that anyone else would have who had worked for months to prepare this test, a feeling of exhilaration that the thing had actually worked. This was followed by another quick reaction, a sort of feeling of relief that I would not have to go to the bomb and find out why the thing didn't work."

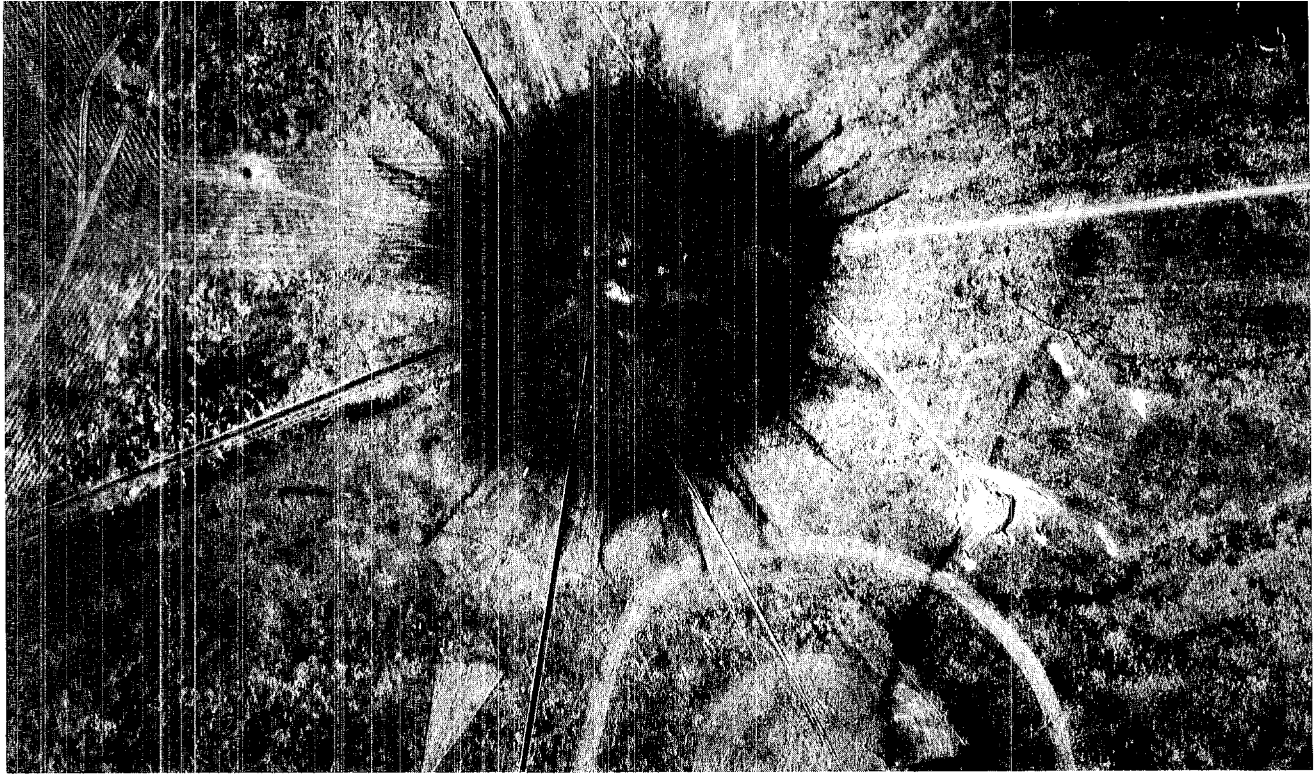
But later he told Oppenheimer, "Now we're all sons of bitches."

Ernest O. Lawrence is quoted as saying that from his vantage point on Compagna Hill, "the grand, indeed almost cataclysmic proportion of the explosion produced a kind of solemnity in everyone's behavior immediately afterwards. There was a restrained applause, but more a hushed murmuring bordering on reverence as the event was commented upon."

At the control point, Farrell wrote, "The tension in the room let up and all started congratulating each other. All the pent-up emotions were released in those few minutes and all seemed to sense immediately that the explosion had far exceeded the most optimistic expectations and wildest hopes of the scientists."

Kistiakowsky, who had bet a month's salary against $10 that the gadget would work, put his arms around the director's shoulder and said, "Oppie, you owe me $10."

Elsewhere the momentous event had not gone unnoticed. The flash of light was seen in Albuquerque, Santa Fe, Silver City, Gallup and El Paso. Windows rattled in Silver City and Gallup. So intense was the light that a blind girl riding in an automobile near Albuquerque asked, "What was that?"



Crater and heat effects scar the desert at Ground Zero.

A rancher between Alamogordo and the test site was awakened suddenly. "I thought a plane had crashed in the yard. It was like somebody turned on a light bulb right in my face."

Another man, 30 miles away in Carrizozo, recalls, "It sure rocked the ground. You'd have thought it went off right in your back yard."

A sleepless patient in the Los Alamos hospital reported seeing a strange light. The wife, waiting on Sawyer's Hill behind Los Alamos, saw it too, and wrote later:

"Then it came. The blinding light like no other light one had ever seen. The trees, illuminated, leaping out. The mountains flashing into life. Later, the long slow rumble. Something had happened, all right, for good or ill."

At the test site, as the spectators watched the huge cloud billow into the sky, the medical officers took over leadership of the three observation points, watching their counters and maintaining contact with Paul Aebersold's crew of monitors patrolling the roads within the test site. An Entry Permission Group, consisting of Bainbridge, Dr. Hemplemann and Aebersold kept track of the reports and made decisions on movement of personnel around the site.

At first there was no sign of danger. Then suddenly, the instruments at N 10,000 began clicking rapidly showing that radioactivity was on the rise. Dr. Henry Barnett, in charge of the shelter, gave the order to evacuate and soon the trucks and cars were roaring past W 10,000 and on to Base Camp. It later proved to be a false alarm. Film badges worn by the personnel at the observation point indicated that no radioactivity had reached the shelter.

Before long those without further duties were permitted to return to Base Camp and those with instruments in the forward areas moved in to pick them up.

As the sun came up, air currents were created which swept radioactivity trapped in the inversion layer into the valley. Geiger counters at S 10,000 began to go wild. The few men remaining there put on masks and watched anxiously as the radioactive air quickly moved away before the danger level was reached. Around 9:30 a.m. Bainbridge radioed the men in the slit trench at Mockingbird Gap to return to Base Camp.

Shortly afterward a lead-lined tank, driven by Sgt. Bill Smith and carrying Herbert Anderson and Enrico Fermi, moved in to Ground Zero to recover equipment and to study debris in hope of getting information on long range detection of atomic explosions. The tank was equipped with a trap door through which earth samples could be safely picked up in the crater.

Fermi later reported to his wife that he found "a depressed area 400 yards in radius glazed with green, glass-like substance where the sand had melted and solidified again."

Meanwhile, General Groves, who had planned to wait at Base Camp until all danger of fallout was passed, hoped to make good use of the hours by discussing with Los Alamos people a number of problems connected with the next job on the agenda, the bombing of Japan.

"These plans were utterly impracticable," he wrote later, "for no one who had witnessed the test was in a frame of mind to discuss anything. The success was simply too great. It was not only that we had achieved success with the bomb; but that everyone—scientists, military officers and engineers—realized we had been personal participants and eyewitnesses to a major milestone in the world's history."

But Groves had other problems to keep him busy anyway.

The explosion had generated considerable excitement around the state and as far away as El Paso. At Associated Press in Albuquerque, the queries coming in were becoming more difficult to handle. Intelligence Officer Lt. Phil Belcher, now the Laboratory's Documents Division leader, was stationed at Albuquerque to keep any alarming dispatches about the explosion from going out. About 11 a.m. the AP man told Belcher he could no longer hold back the story. If nothing is put out now by the Army, he told him, AP's own stories would have to go on the wire.

The Army was prepared for this kind of determination. Weeks before a special press release had been prepared and sent to the Alamogordo Bombing Range with Lt. W. A. Parish from Groves' office. With it, Parish also carried a letter to the commanding officer, Col. William Eareckson, instructing him to follow Lt. Parish's instructions, no questions asked.

About 11 Parish was instructed to make his release:

Alamogordo, July 16—The Commanding Officer of the Alamogordo Army Air Base made the following statement today:

"Several inquiries have been received concerning a heavy explosion which occurred on the Alamogordo Air Base reservation this morning.

"A remotely located ammunition magazine containing a considerable amount of high explosives and pyrotechnics exploded.

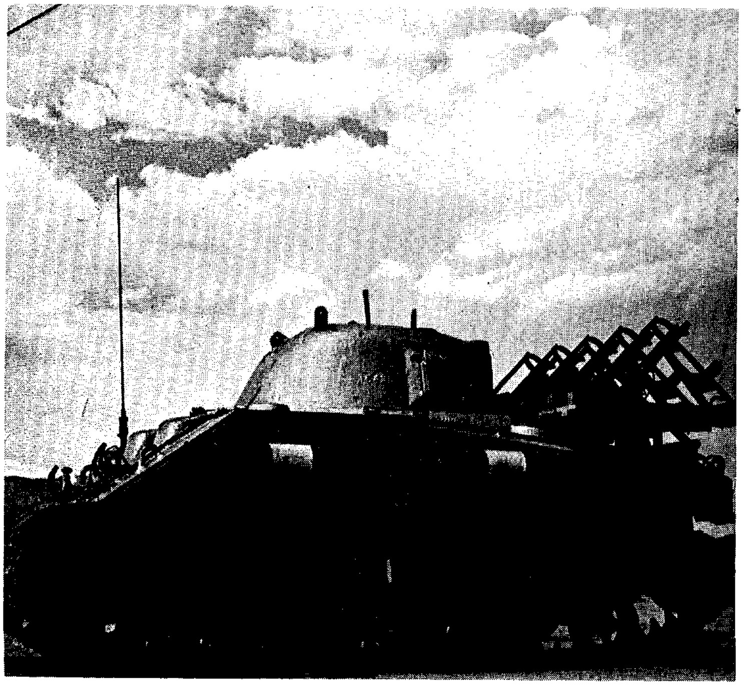
"There was no loss of life or injury to anyone, and the property damage outside of the explosives magazine itself was negligible.

"Weather conditions affecting the content of gas shells exploded by the blast may make it desirable for the Army to evacuate temporarily a few civilians from their homes."

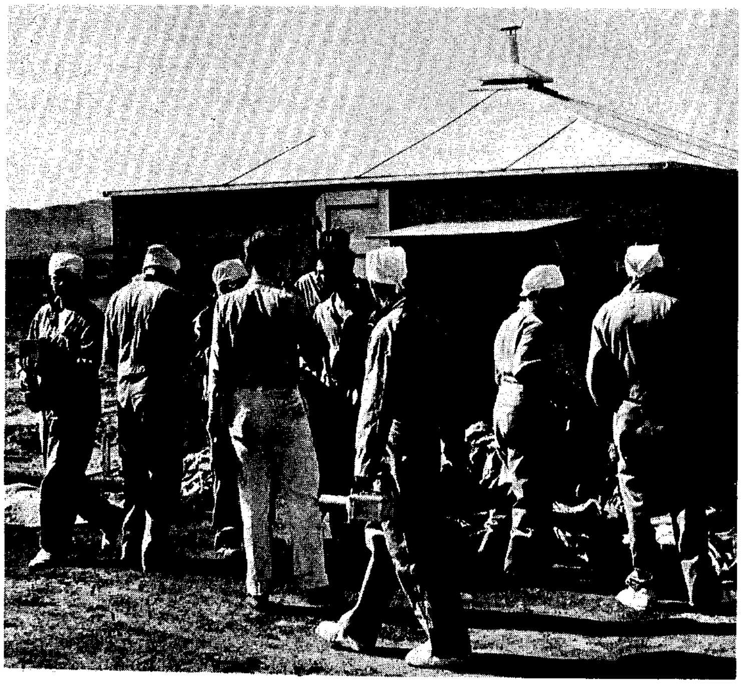
The news ran in New Mexico papers and spread up and down the West Coast by radio. It didn't fool everyone. Some days later, Groves reports, he was dismayed when a scientist from the Hanford project said to him: "By the way, General, everybody at DuPont sends their congratulations."

"What for?" the general asked innocently.

"This is the first time we've ever heard of the



This special lead-lined tank was used by Enrico Fermi and Herbert Anderson for obtaining soil samples from the crater shortly after the test.



Recovery team and radiation monitors assemble for action a few hours after the test.

Army's storing high explosives, pyrotechnics and chemicals in one magazine," he replied.

Colonel Eareckson has since been nominated by sympathetic historians as one of the unsung heroes of World War II. Not only was he forced to take the blame for this gross mishandling of explosives, but he had to take his orders that day from a mere lieutenant.

By late afternoon it was clear there would be no difficulty with fallout. Bainbridge finally left the control center about 3 p.m. to return to the Base Camp for food and rest. General Groves, Conant and Bush left for Albuquerque to begin the trip back to Washington.

Groves' secretary, Mrs. Nora O'Leary, who had been standing by in Washington since early morning for word of the test, received a coded message from her boss and at 7:30 p.m. sent the following message to Secretary of War Stimson at Potsdam:

"Operated on this morning. Diagnosis not yet complete but results seem satisfactory and already exceed expectations. Local press release necessary as interest extends a great distance. Dr. Groves pleased. He returns tomorrow. I will keep you posted."

Although it would be weeks before the measurement could be correlated and interpreted it was immediately apparent that the implosion weapon was a technical success. The fire ball, Fermi's calculations with bits of paper and other data available immediately indicated the yield had been greater than the most optimistic predictions. It was therefore possible for Groves to follow up his first message to Potsdam with another optimistic one the next day:

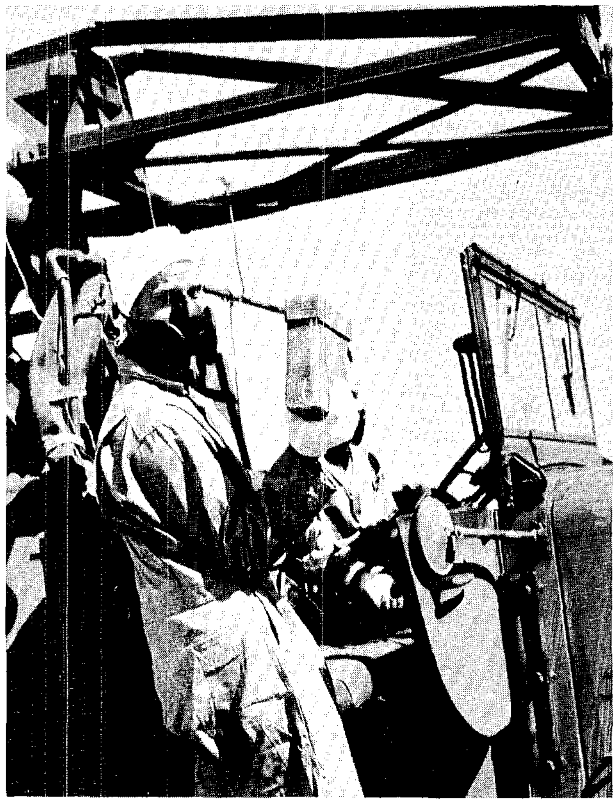
"Doctor has just returned most enthusiastic and confident that the little boy is as husky as his big brother. The light in his eyes discernible from here to Highhold and I could hear his screams from here to my farm."

The message was clear. The power to crush Japan had taken on a new dimension. The device had worked beyond expectations, its flash seen for 250 miles, its thunder heard for 50, and Groves was sure the plutonium bomb was as potent as the uranium gun.

Through the day of July 16, cars of weary, excited men headed back toward Los Alamos. There was still a great deal of work to be done and for those who were going overseas, the test had simply been a rehearsal.

A new Fat Man was scheduled to be delivered August 6.

When they stopped for meals in Belen the men talked of inconsequential things and listened to mystified citizens discussing the strange sort of thunder they had heard that morning and the way "the sun came up and went right back down again."



Recovery man rescues film from the crater area.

Occupants of one car did not recognize the occupants of the other. Security was as tight as ever. It was not until they reached the guarded gates of Los Alamos that the flood of talk burst loose.

Mrs. Fermi recalls the men returning late that evening. "They looked dried out, shrunken. They had baked in the roasting heat of the southern desert and they were dead tired. Enrico was so sleepy he went right to bed without a word. On the following morning all he had to say to the family was that for the first time in his life on coming back from Trinity he had felt it was not safe for him to drive."

"I heard no more about Trinity. The men resumed their work at the usual fast pace," she concluded.

But during the day, rumors of the brilliant light so many had watched for and seen spread through the town. Although few people knew officially what had happened, most were able to sense or guess that the project to which each had contributed his part during the long hectic months had been accomplished

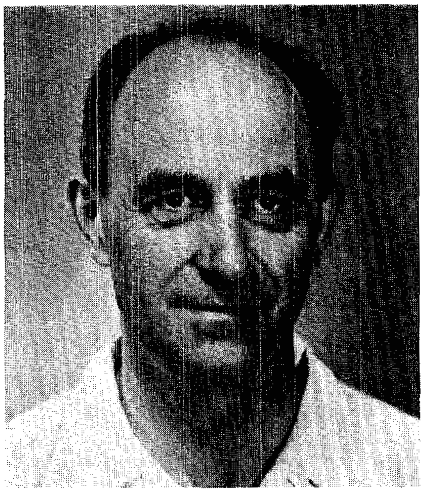
When he returned to the Hill that night, Fred Reines found the town jumping. One of the janitors Reines knew spotted the returning scientist, grinned proudly and said, "We did it, didn't we?"

"We sure did," Reines told him.

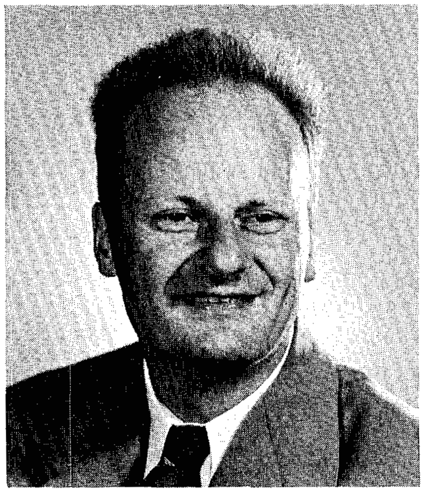
they built the bomb

These men directed the atomic bomb project at Los Alamos. Most were division leaders, some played other key roles. None of them were alone. There were dozens more brilliant young scientists who made significant contributions. There were countless technicians, administrative people, soldiers and WACs without whom the work could not have been done. Not the least were the wives to whom, John Williams once said, should go much of the credit. "They lived in uncertainty and sometimes fear during those trying years. They never knew what their husbands were doing and they never asked."

Kenneth Bainbridge
Test Director



Enrico Fermi
Theory



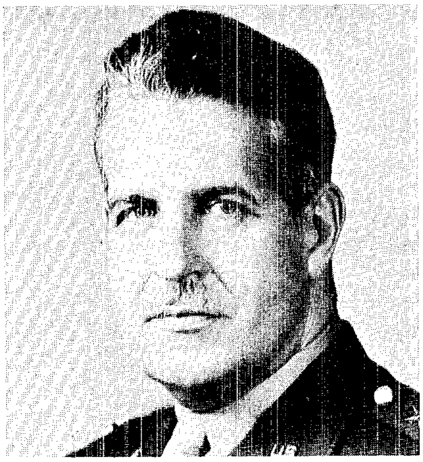
Hans Bethe
Theory

John Williams
Deputy Test Director

George Kistiakowsky
Explosives

Robert Bacher
Weapons Physics

Maj. Gen. Leslie R. Groves
Director
Manhattan Engineer District



J. Robert Oppenheimer
Director

Victor Weisskopf
Theory

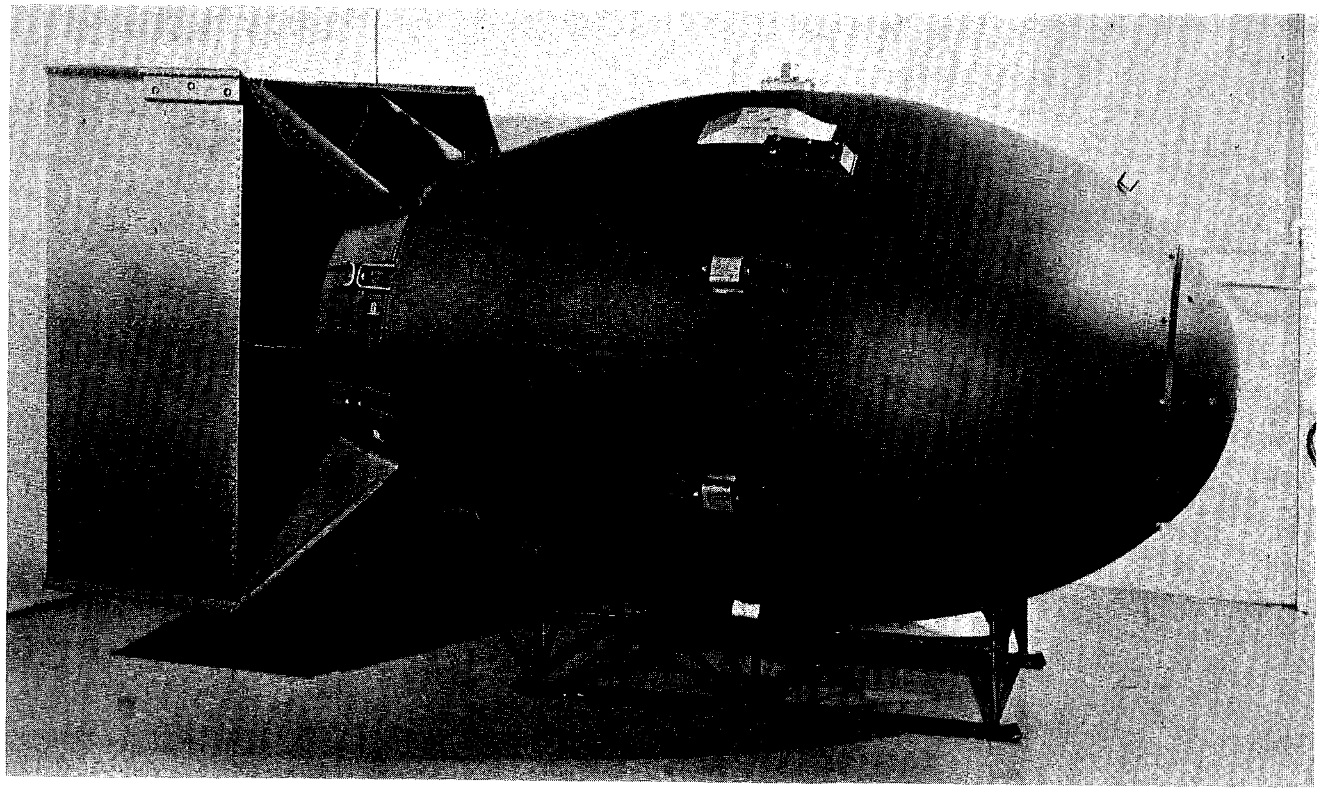
John von Neumann
Theory

Robert Wilson
Physics Research

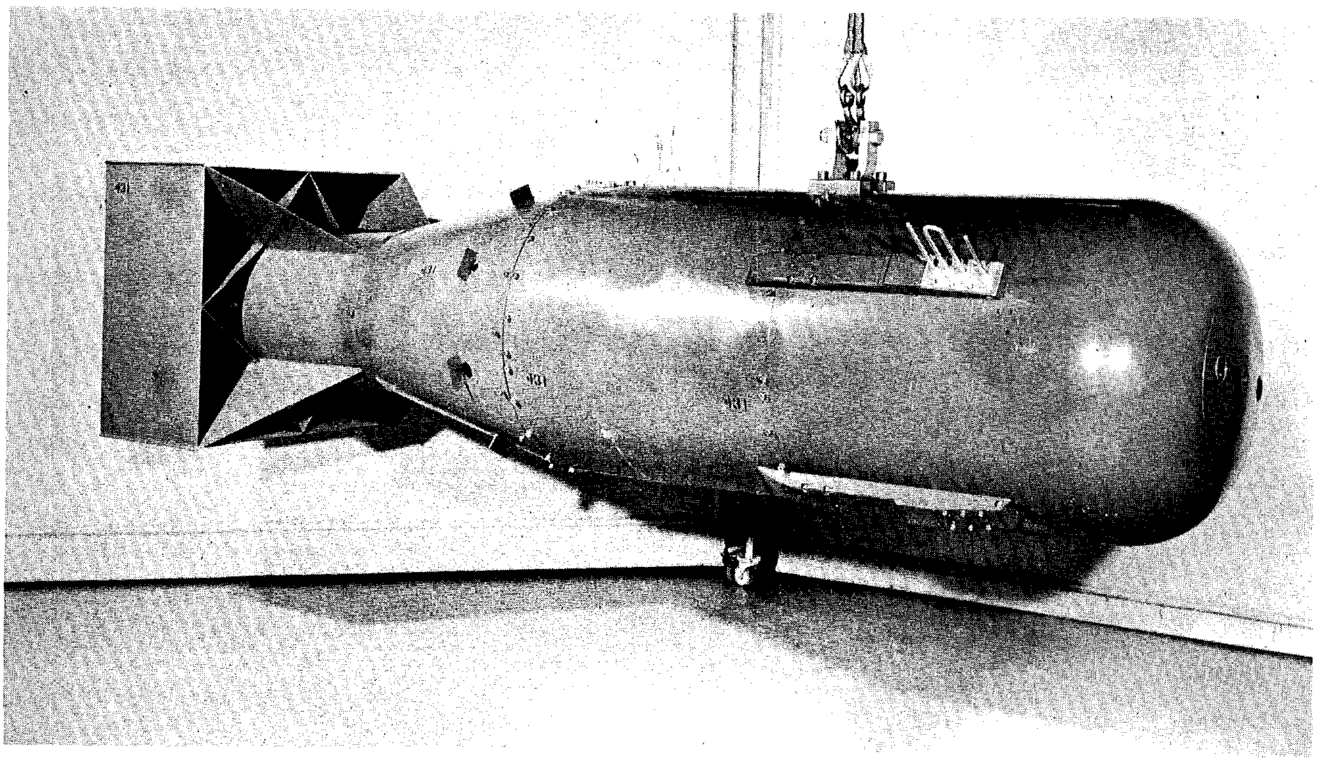
Cyril Smith
Metallurgy

Eric Jette
Plutonium Metallurgy

William Parsons
Ordnance



Above: Fat Man, the implosion-type plutonium weapon, the kind detonated over Nagasaki. Bomb is 60 inches in diameter and 128 inches long, weighed 10,000 pounds. Below: Little Boy, gun-type uranium weapon, the kind detonated over Hiroshima. It weighed 9,000 pounds, measured 28 inches in diameter.



PART II

BUILDING THE BOMB

by JOHN SAVAGE

the theory

Done it, indeed they had. And what they had done that historic day 20 years ago owed a great deal to what had been done long before.

Years before the beginning of World War II, scientists everywhere understood that the atomic nucleus held great promise as a source of energy. Many scientists expected that some day the promise would be fulfilled. Other scientists were not so sure. Nature had locked up her nuclear energy in apparently tamper-proof packages.

An atomic nucleus is equally at home in a deep-freeze or a volcano. A century in boiling acid would have no effect on the nucleus of any atom. When a stick of dynamite explodes, its atoms shift themselves violently into fresh chemical combinations, but the nuclei remain unchanged.

The nuclear package is not only tough but small. The largest atomic nucleus in the world is about as many times smaller than a pea as a pea is smaller than the sun. Therefore, though each nucleus contains a great deal of energy *for its size,* the energy of a single nucleus amounts to very little. The release of nuclear energy in useful quantities requires the opening of billions upon billions of nuclear packages.

No way of doing this was clearly seen until 1939.

Five years earlier, in an Italian laboratory, Enrico Fermi had performed an interesting experiment. By bombarding uranium (then the heaviest element on earth) with tiny particles called neutrons, he had produced elements that were no longer uranium. These new elements were created in such small quantities that they could not be examined by simple means, but Fermi knew—or thought he knew—what they were: They must be elements even heavier than uranium, formed when uranium nuclei absorbed neutrons.

Other experimenters, especially in France and Germany, grew interested in identifying Fermi's new "transuranium" elements. By January, 1939, these experiments had shown that Fermi was mistaken about at least two of his products. These two were positively identified as barium and lanthanum—elements not heavier than uranium, but only about half as heavy.

Where had the barium and lanthanum nuclei come from? By the middle of January, the correct answer had been proposed and widely accepted: Some of the uranium nuclei had reacted to the absorption of neutrons by splitting into two smaller parts. It was further proposed, and soon proved, that these two "fission fragments" flew apart from each other with great speed, acquired because of the release of nuclear energy.

One kind of nuclear package, then, could be opened by means of neutron bombardment. This fact had great scientific importance, but it was not enough, by itself, to show the way to nuclear energy release on a practical scale. What remained to be discovered was a way of opening the packages by the billions, without pouring billions of neutrons in.

Before the end of that same January (a big month) the way was found at least in theory. It was first suggested and then demonstrated that when a uranium nucleus underwent fission (splitting in two), *it released not only energy but neutrons.* This was clearly of the utmost importance. If neutrons from fission could cause other fissions, the problem would be solved. The packages could open one another, so to speak, automatically.

That was the principle. It would be a chain reaction, with one fission causing others and those causing still others.

It is not recorded that anybody said it would be easy to make the principle work. The potential benefits, however, appeared to be worth a considerable effort. One neutron, carrying a very small amount of energy, could release several billion times that much energy from a uranium nucleus. The complete fission of one gram of uranium (a piece no bigger than a radish seed) would yield as much energy as the burning of three tons of coal or nearly 700 gallons of fuel oil.

A great world war was about to begin. The potentialities of nuclear energy for the peaceful benefit of mankind were immediately overshadowed by its potentialities for use in weapons.

The sudden release of a great deal of energy in a small volume produces an explosion. The sudden fission of the nuclei in a few pounds of uranium would, it was seen, produce the largest man-made explosion in history.

It was obvious to American scientists, and to foreign scientists in the United States, that information about fission might have military value. For that reason, under a voluntary agreement, these men refrained from publishing any new information on that subject, from the spring of 1940 until almost the end of the war. News of the discovery of nuclear fission itself could not be suppressed, since it had been made public in 1939, but the scientists reasoned (correctly) that a vast quantity of additional knowledge would have to be acquired before a nuclear weapon could be designed.

A lump of uranium is not a bomb. It is about as much like a bomb as a bucket of low-grade iron ore is like a fine watch. The wartime nuclear weapon program faced huge problems—problems of materials and problems of design.

In 1934, when Enrico Fermi bombarded uranium with neutrons, only a very small fraction of the uranium nuclei underwent fission. One reason for this was that his uranium sample, like all of the uranium in the world at that time, was composed almost entirely of the wrong kind of uranium.

Pure uranium is a dark gray metal, obtained from various ores on several continents. Its "atomic number" is 92, which means that every uranium nucleus, by definition, contains 92 protons (positively charged component particles). Along with this fixed number of protons, however, each uranium nucleus contains an even larger number of the *un*charged particles called neutrons, and this number is *not* fixed. Uranium as it occurs in nature is a mixture of three kinds of uranium (92-proton) atoms, differing in the number of neutrons each kind contains.

The most abundant of these kinds, or isotopes, has a "mass number" (total number of protons and neutrons) of 238. Uranium 238 makes up more than 99 per cent of the naturally occurring mixture. The rest of the mixture consists of U-235 (0.72 per cent) and a negligible percentage of U-234. For practical purposes, then, natural uranium consists of U-238 and U-235, in proportions of about 140 to 1.

These numbers are important for a special reason, vital to the nuclear weapon program: Though U-238 and U-235 are practically identical in their chemical behavior (and are therefore extremely difficult to separate), they are quite different in their *nuclear* behavior. U-238, the abundant isotope, is unsuitable for use as the fissionable material in a bomb. Only very fast neutrons can cause it to fission, and it has a tendency to decelerate neutrons and then capture them without fissioning. U-235 is fissionable by neutrons of all speeds.

By 1940 this difference was understood, and it was known that natural uranium, with its great preponderance of U-238, would not serve as a bomb core. An attempt would have to be made to prepare a special kind of uranium, unnaturally enriched in the rarer isotope, 235. The attempt would be costly, and its ultimate success was not at all certain.

Meanwhile, on almost purely theoretical grounds, an entirely different kind of fissionable material was suggested. It was a material without a name—an element no one had ever seen. This element would later be called plutonium.

As early as 1939, it had been predicted that when a U-238 nucleus captured and absorbed a neutron, the resulting U-239 would quickly convert itself (by the emission of two electrons) into an element of atomic number 94. It had been predicted further that element 94 (at mass 239) would turn out to be readily fissionable.

Therefore, two possibilities existed for the bomb core. One possibility was enriched uranium (uranium in which the natural proportions of the isotopes had somehow been altered in favor of U-235). The other possibility was element 94 (plutonium), of which the required quantities could be made only by means of some device producing a fantastically copious supply of neutrons for bombarding U-238 nuclei. No such device existed.

So much for the problem of materials, as that problem looked in 1940. The problem of bomb design was destined to receive little concentrated attention until 1943, but everyone knew that it held mysteries of its own.

The design would have to be such that the bomb would be capable of exploding, and capable of exploding only at the proper time. Both "capable of exploding" and "only at the proper time" represented essential requirements, rich in potential difficulties.

A nuclear fission explosion, whether in plutonium or in uranium, requires the disruption of a huge number of nuclei. The process is initiated, however, by a relatively small number of free neutrons (neutrons not bound in any nucleus). One free neutron invades a nucleus and causes fission, producing high-energy fragments and two or three newly-free neutrons, which carry on the chain reaction. In a very small fraction of a second, the multiplication of free neutrons results in practically instantaneous fission of a large percentage of the nuclei present.

But how does one arrange for such an explosion?

It isn't easy. For one thing, each of the atoms of fissionable material consists—like a miniature solar system—mostly of empty space. There is no attractive force between the free neutron and the target nucleus until the two are practically in contact. The fast-moving neutron flies through the large spaces between nuclei, missing a great many nuclei before it happens to hit one, if it ever does. If its path reaches the surface of the fissionable mass, the neutron simply escapes, without having touched a nucleus.

There is no way of predicting whether or not an individual neutron will collide with a nucleus and cause fission. The chances can be calculated only statistically, like the chances of automobile collisions on a holiday week-end.

How can the chances be improved? One way is by increasing the dimensions of the fissionable mass, so that most of the neutrons have to travel farther to get out. Another is by putting a suitable reflector around the mass, so that escaping neutrons will bounce back in. Another is by compressing the fissionable mass, to decrease the distance between nuclei. Still another (because impurities can capture neutrons and take them out of circulation) is by increasing the purity of the fissionable material.

Much work needed to be done on all four of the ways just mentioned, if there was ever to be an atomic bomb capable of exploding. Making it explode at the right time was an additional challenge.

As implied in an earlier paragraph, if the fissionable mass is too small, too many neutrons will escape without causing fission. The minimum quantity of fuel that will support a chain reaction is called a critical mass. This quantity varies with (among other things) the shape and purity of the fuel, but it is ordinarily several kilograms. (A kilogram is 2.2 pounds.)

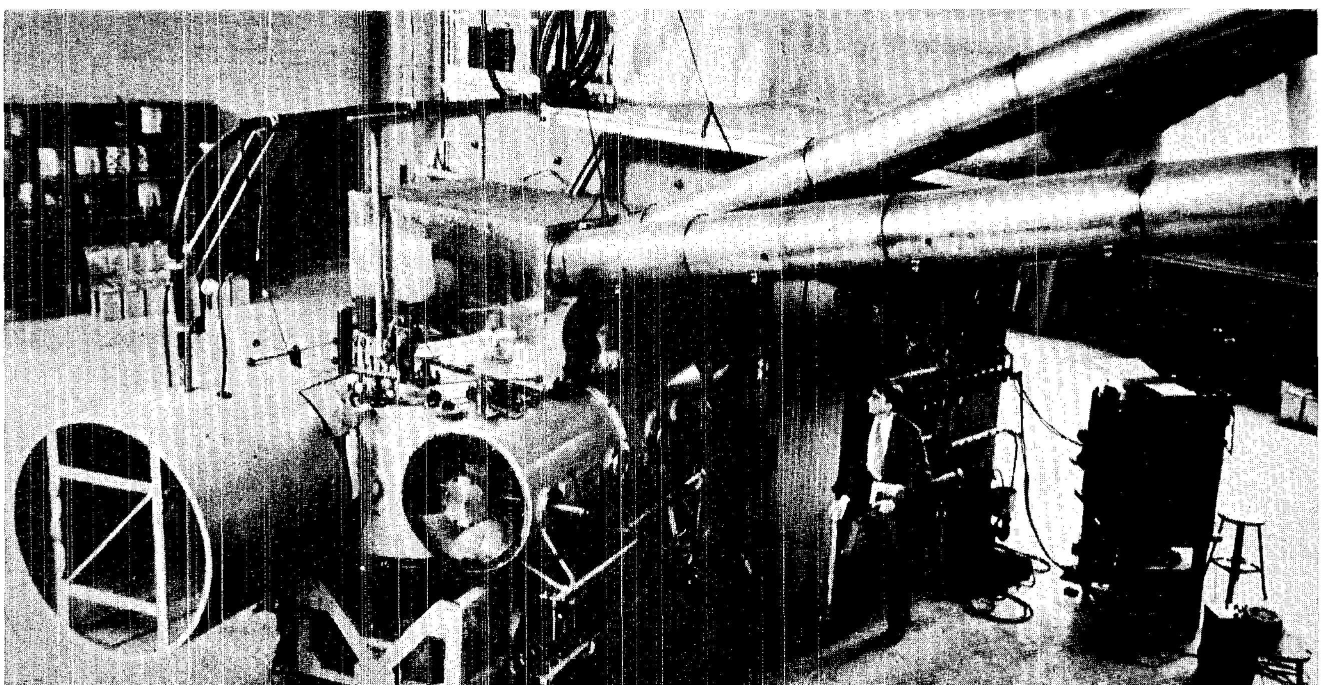
The twin problems of initiating the explosion at the right time and preventing initiation before that time would have been simplified if it had been possible to assemble a critical mass, store it until an explosion was desired, and then inject a neutron into it. Unfortunately, stray neutrons are everywhere around us. They wander through everything, including the cores of fission bombs—where other neutrons are occasionally set free by spontaneous fissions, besides. Thus, in any critical mass of fissionable material, a chain reaction cannot be prevented or delayed; it will occur almost instantly.

For that reason, no nuclear fission weapon can be fully assembled in a laboratory or arsenal. Final assembly must occur only at the target, as a part of the detonation procedure.

Developing a bomb which would incorporate mechanisms for its own final assembly was destined to be one of the thorniest problems of the nuclear weapon project.

Preparing the materials would be difficult. Designing the bomb would be difficult. And without a vast research effort, aimed at learning more about the chemistry and physics of uranium and plutonium, both tasks would be impossible.

The 60-inch cyclotron at the University of California's Lawrence Radiation Laboratory in Berkeley was used in the discovery of plutonium and six other elements. 1939 photo shows the east side of the machine.



preparing the materials

Of the three atomic bombs detonated in 1945—one at the Trinity test and two over Japanese cities—one (the Hiroshima bomb) had a uranium core. The Trinity and Nagasaki devices had plutonium cores. Preparation of these two fissionable materials had been accomplished against almost overwhelming odds.

In the case of uranium, the difficulty arose from the fact that uranium 238 and uranium 235 are almost identical substances. Each of the two kinds of atoms has 92 nuclear protons and 92 orbital electrons. Since the chemical behavior of any atom is almost entirely governed by its orbital electrons, the two kinds of uranium could not be separated by chemical processes. Some other process—a purely physical one—was required.

U-235 has 143 neutrons in each nucleus. U-238 has 146. Somehow, those three extra neutrons had to be used to make the U-238 atoms go one way and the U-235 atoms go another. A great many methods were suggested. Half a dozen or so, including a centrifuge process like the one used to separate cream from milk, were given extensive trials. Almost every idea worked, but no idea worked very well. The difference between the two isotopes was too small.

Furthermore, all of the separation methods tried were expensive. If the isotope separation program had been an industrial enterprise, aimed at making a profit, the only sensible course would have been to close up shop.

But there was a war on. Nobody knew how much effort, if any, Germany might be devoting to nuclear weapon development (actually it was very little), but one thing was almost certain: If the Germans were first to develop a nuclear weapon, Hitler would win the war. This was no time to pinch pennies.

America's decision, based partly on extremely good work by scientists in Britain, was to continue at any cost. Investigation of many ways of separating isotopes would go on, and a really vast effort would be made on the two most promising processes. One of these was gaseous diffusion separation and the other was electromagnetic separation.

Both processes are based on the difference in weight (more properly, in mass) between the two kinds of uranium nuclei.

The molecules in a gas are in constant motion. The warmer the gas, the faster its molecules move; but some move faster than others. On the average, heavier molecules are more sluggish than light ones. They move more slowly. Therefore, when a gas diffuses through a porous barrier, the lighter molecules get through a little more often (at first) than the heavier ones.

Perhaps unfortunately, uranium is not a gas. For the gaseous diffusion process, the uranium has to be combined with fluorine to produce an easily-vaporized compound called uranium hexafluoride. Uranium hexafluoride gas is extremely corrosive, tending to attack pumps, piping, barriers, and almost anything else it happens to touch.

But the gaseous diffusion method works. Passage through each barrier in a multi-stage separation plant increases (very slightly) the concentration of U-235 in some of the gas. By using thousands of stages, thousands of miles of piping, and hundreds of acres of barriers, it is possible to produce very highly enriched uranium hexafluoride. Uranium metal made from the enriched gas has a very low concentration of U-238.

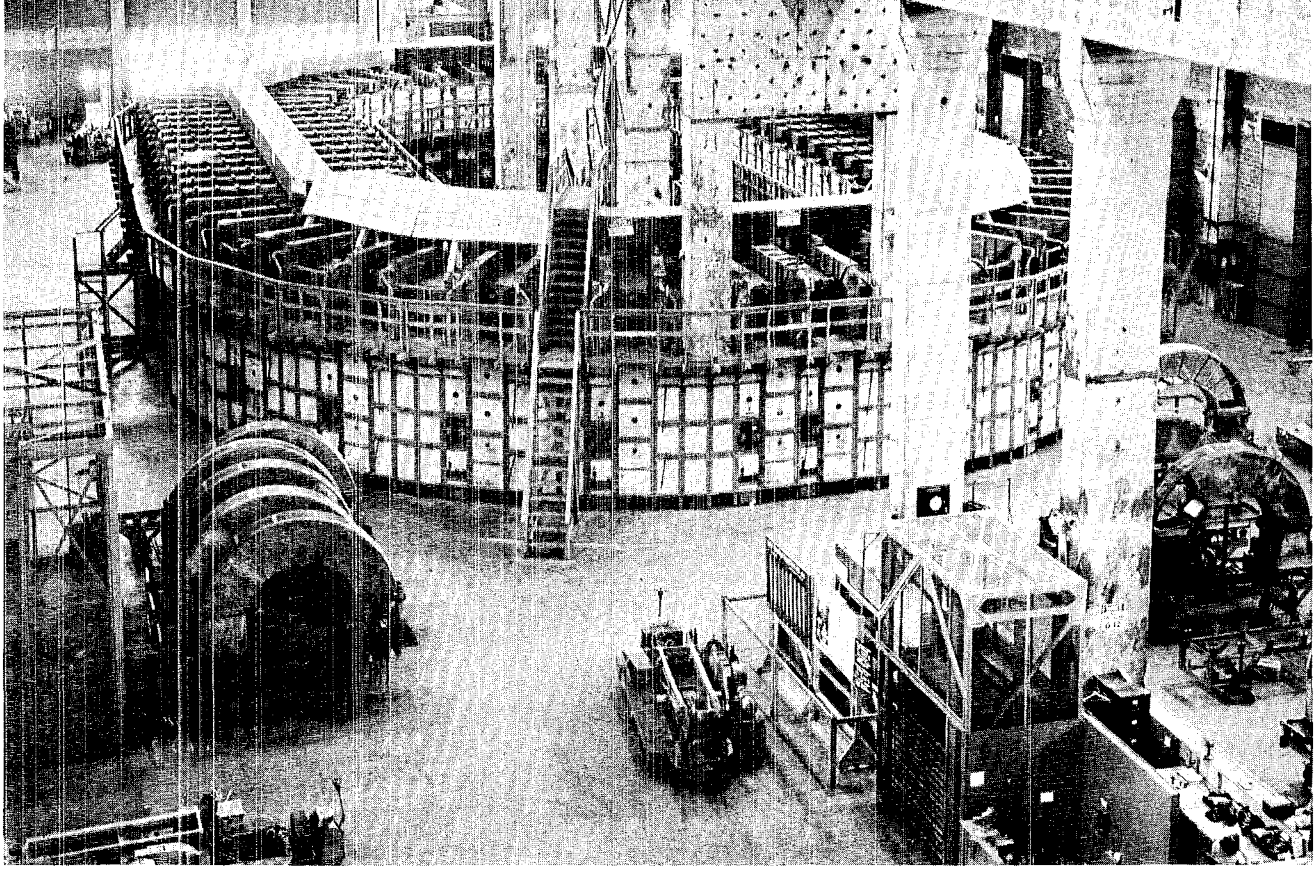
A large part of the wartime project consisted of planning and building a separation plant to employ the principle just described. The plant was built in Oak Ridge, Tennessee, in the years from 1943 to 1945.

The electromagnetic separation process is quite different, but it also exploits the very slight mass differences created by the presence of those three extra neutrons in each U-238 nucleus.

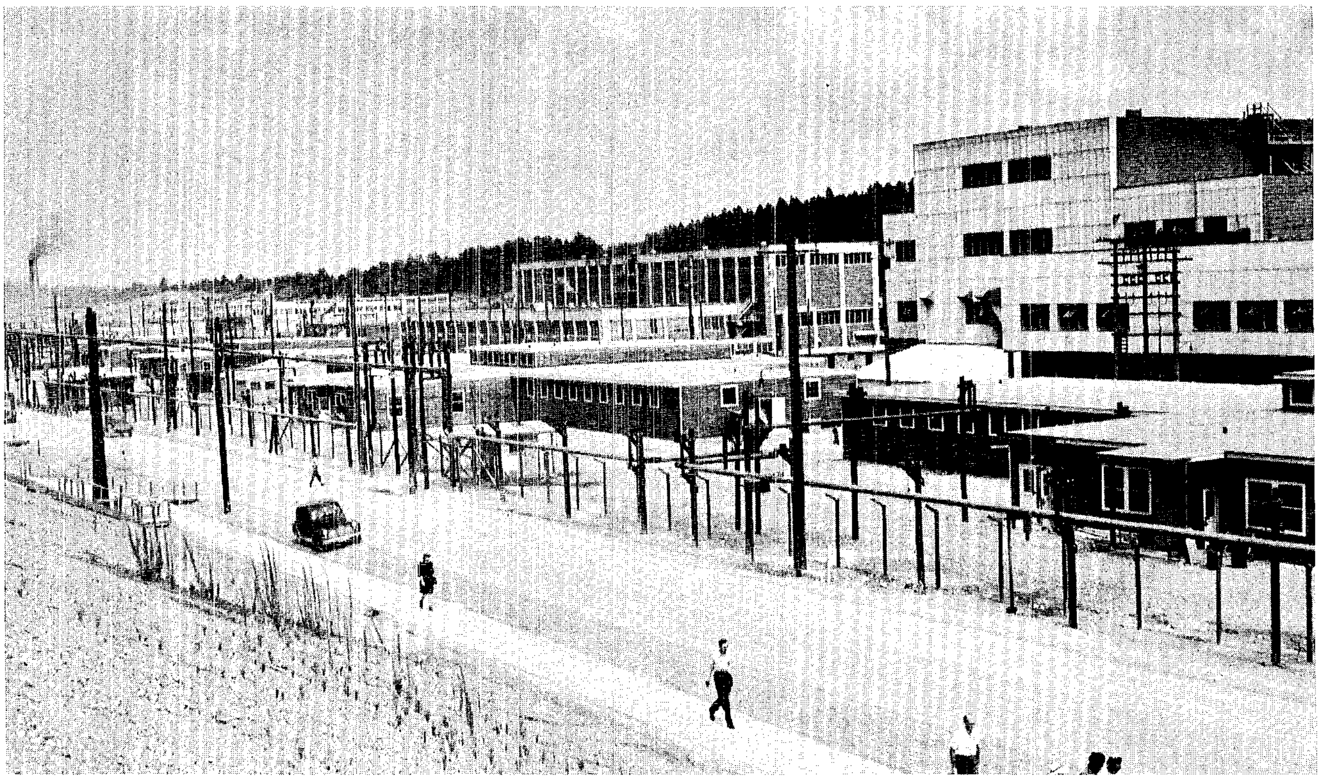
Everything possessing mass has inertia. The more mass, the more inertia. It is perhaps usual to think of inertia as a reluctance to move, but inertia is a broader phenomenon than that. It is less a resistance to movement than a kind of resistance to *change*. If an object is stationary, inertia makes it reluctant to move; if it is moving, inertia makes it reluctant to stop or to change direction.

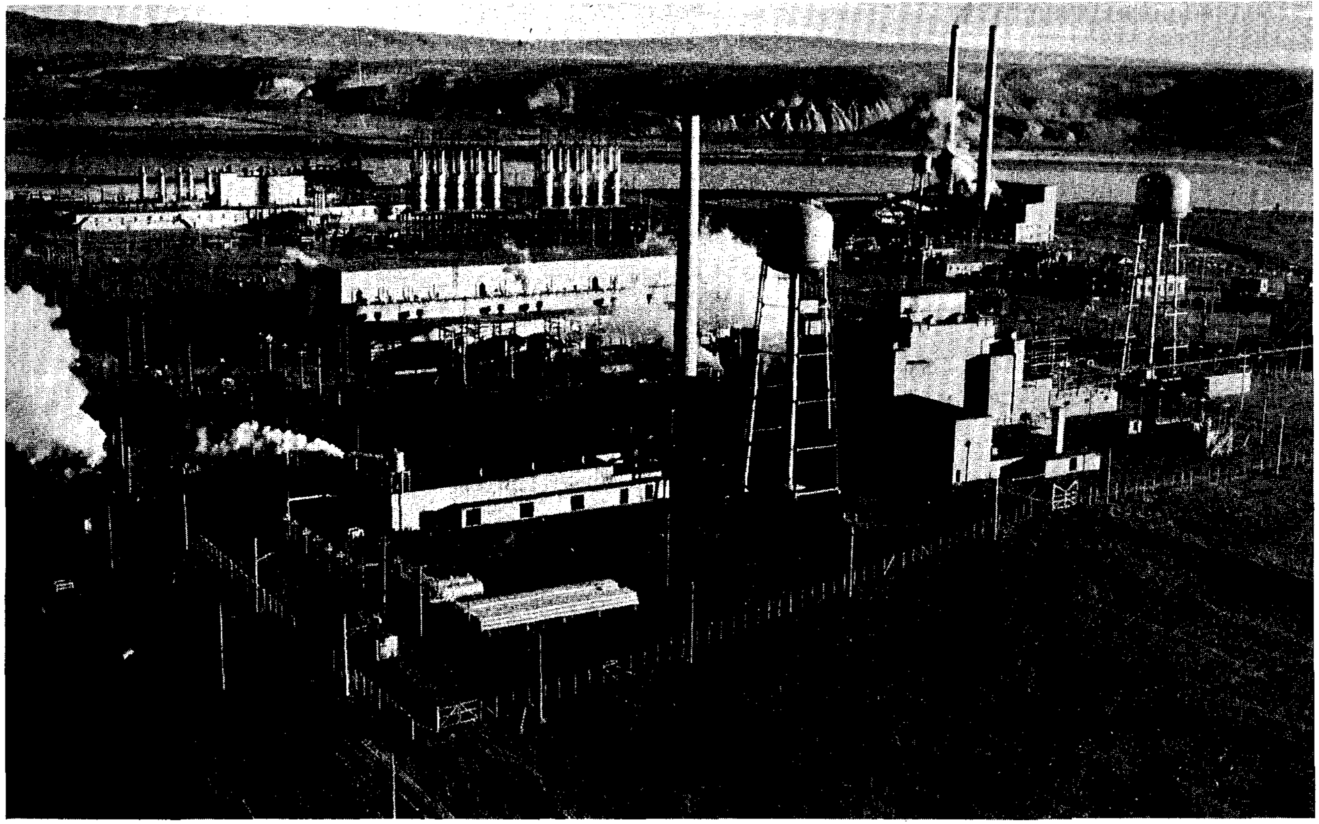
Since inertia is proportional to mass, the U-238 nucleus has a little more inertia than the U-235 nucleus. If both are traveling at the same speed, the heavier nucleus will have a slightly stronger resistance to any change in direction. Therefore, a given force tending to change the direction of motion will have a slightly greater effect on the lighter nuclei than on the heavier.

This principle is exploited in the electromagnetic separation of isotopes in the following way: First, the uranium atoms are "ionized," usually by being deprived of one orbital electron each. This leaves the atoms positively charged, so that they can be accelerated electrically and acted on magnetically. When they have been accelerated—many millions of them at a time—they are formed into a beam, all traveling in the same direction. The beam of ura-



Above: A section of the electromagnetic process equipment, used for enriching uranium, in the Y-12 plant at Oak Ridge. Units of the electromagnetic system, called "calutrons," are used today to produce stable isotopes for peaceful purposes. Below: A wartime view of the huge electromagnetic processing plant.





One of eight plutonium-producing reactor facilities at Hanford works. This one operated for the first time with full loading on December 17, 1944.

nium ions is then passed through a magnetic field which has been arranged in such a way as to bend their trajectories. Under the influence of the magnetic field, the U-235 ions change direction more than the U-238 ions. The beam becomes two beams, each of which can be caught in a separate receptacle.

Though the development of the electromagnetic separation process encountered many difficulties, the method ultimately succeeded in producing important quantities of U-235. Electromagnetic separating machines called "calutrons," developed by the University of California, were installed at Oak Ridge. They were used mainly to increase the enrichment of already-enriched products of the immense gaseous diffusion plant and of a smaller thermal diffusion plant, which used uranium hexafluoride in liquid form.

By late 1944, highly enriched uranium compounds were being produced at Oak Ridge in kilogram quantities.

Meanwhile, the program to produce the previously unknown element of atomic number 94 had made great strides.

Berkeley scientists produced minute quantities of plutonium in the winter of 1940-41, by bombardment of uranium with particles from an accelerator. The new element proved to be readily fissionable, as had been predicted.

However, production in quantities of military significance could not be carried out with particle accelerators. What was needed was a really plentiful source of free neutrons. The only sufficient source would be a nuclear fission reactor.

Fission reactors are devices in which a chain reaction is maintained under controlled conditions. No such device had been built when the Berkeley scientists produced their first plutonium. It would take two more years to achieve the first man-made fission chain reaction.

The leader in that achievement was the same Enrico Fermi who had first split the uranium nucleus. He had come to the United States and was working at the University of Chicago.

Fermi and his associates sought to demonstrate the possibility of a fission chain reaction in natural uranium—uranium containing less than one per cent U-235. Though a natural-uranium reaction would release energy at a rate unsuitable for an efficient nuclear explosion, the demonstration that such a reaction could be maintained would have great significance. Among other things, it could lead to the construction of reactors capable of producing large quantities of plutonium.

In Fermi's experiment, lumps of natural uranium metal and of natural uranium oxide were placed in a "lattice" (a system of regular spacing) within a pile of graphite blocks.

The graphite was necessary to enable the pile to sustain a chain reaction. Here is why:

When a uranium nucleus undergoes fission, neutrons come out at high velocity. In a natural uranium system, these high-speed neutrons collide with uranium nuclei of both kinds. Some of the collisions cause fission, but many others do not. Most of the neutrons become involved in a series of "elastic" (glancing or bouncing) collisions with nuclei. Such collisions do not cause fission, and each such collision robs a neutron of some of its speed.

It happens that the velocity of a neutron has a large effect on what the neutron can do to a uranium nucleus. As the velocity goes down, the neutron loses its ability to cause fission in U-238, while acquiring *even greater* ability to cause fission in U-235. At what is called "thermal" velocity (when the neutron has lost all of the initial impulse it received from the fissioning nucleus) its ability to cause fission in U-235 is very high.

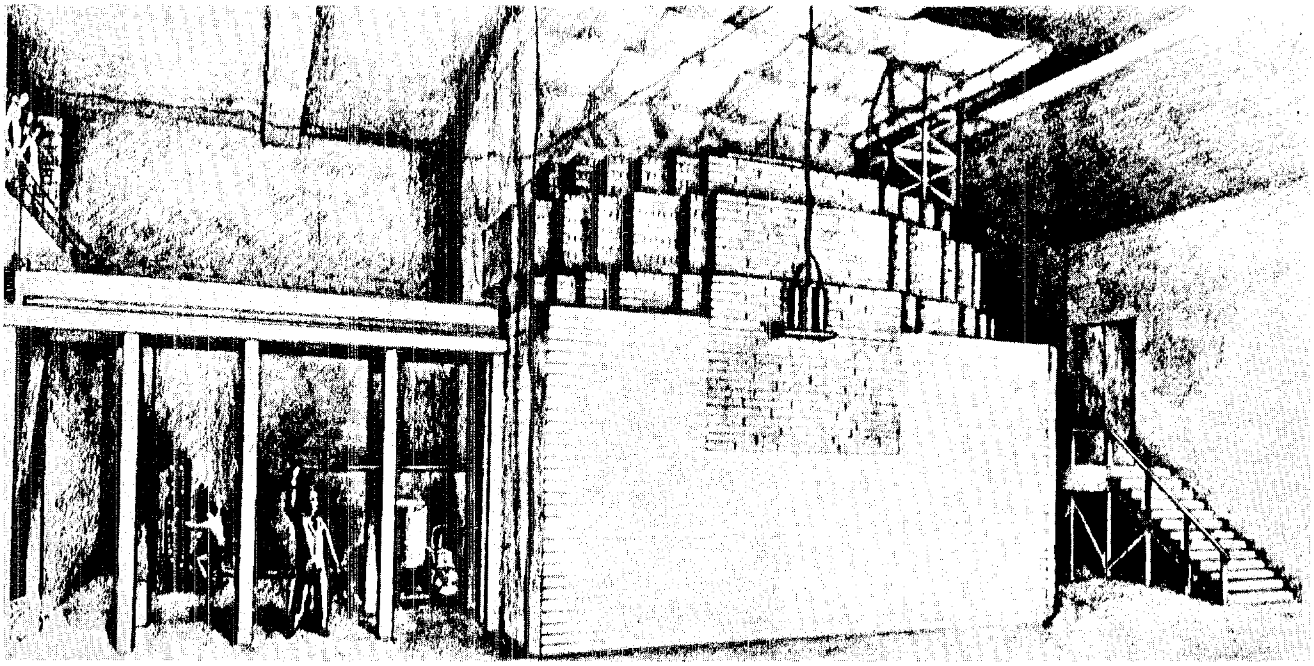
Unfortunately, there is a certain intermediate velocity at which a neutron is most likely to be captured by a U-238 nucleus, without causing fission. In a chain-reacting pile using natural uranium, it is therefore desirable to prevent collisions between medium-speed neutrons and U-238 nuclei. Otherwise, so many neutrons will be captured that the chain reaction will die out. (It is exactly such captures that result in the formation of plutonium, but Fermi was not yet trying for that; his pile would require a maxium number of free neutrons, just to keep the chain reaction alive.)

By using lumps of uranium separated by blocks of graphite, it is possible to avoid many of the neutron captures that would occur in a structure of pure uranium. Neutrons produced by fissions in one lump of fuel fly out of that lump and into the graphite before they have lost enough speed to be captured readily by U-238 nuclei. In the graphite, they lose much of their velocity, because of elastic collisions with carbon nuclei. By the time the neutrons reach the next lump of fuel, they are "thermal" (slow), and are not so likely to be captured by the U-238.

Fermi's pile produced its first sustained chain reaction in December, 1942, exactly one week after the Under Secretary of War had directed that a site at Los Alamos, New Mexico, be acquired for a nuclear weapon laboratory. Fermi's success demonstrated the possibility of the sustained chain reaction and gave great encouragement to those who planned to use larger piles as neutron sources for the production of plutonium.

Construction of one such pile began in Tennessee in 1943. By November of the same year, it was in operation. Within a few months after that, it had produced several grams of plutonium.

However, much larger plutonium production reactors would be necessary for the production of enough plutonium to be used in bomb cores. In June, 1943, construction of such reactors began at Hanford, Washington, where water from the Columbia River could be used as a reactor coolant. By September, 1944, the first Hanford pile was in operation. Plutonium nitrate from Hanford would soon join the flow of fissionable material that was already moving from the uranium and plutonium production facilities in Tennessee toward the Los Alamos Laboratory.



A sketch of Fermi's chain-reacting pile at the University of Chicago.

learning about the materials

Even before the United States entered World War II, research on the properties of fissionable materials began in Britain and America. By the end of 1941, the following American institutions held government contracts for work relevant to the nuclear weapon program:

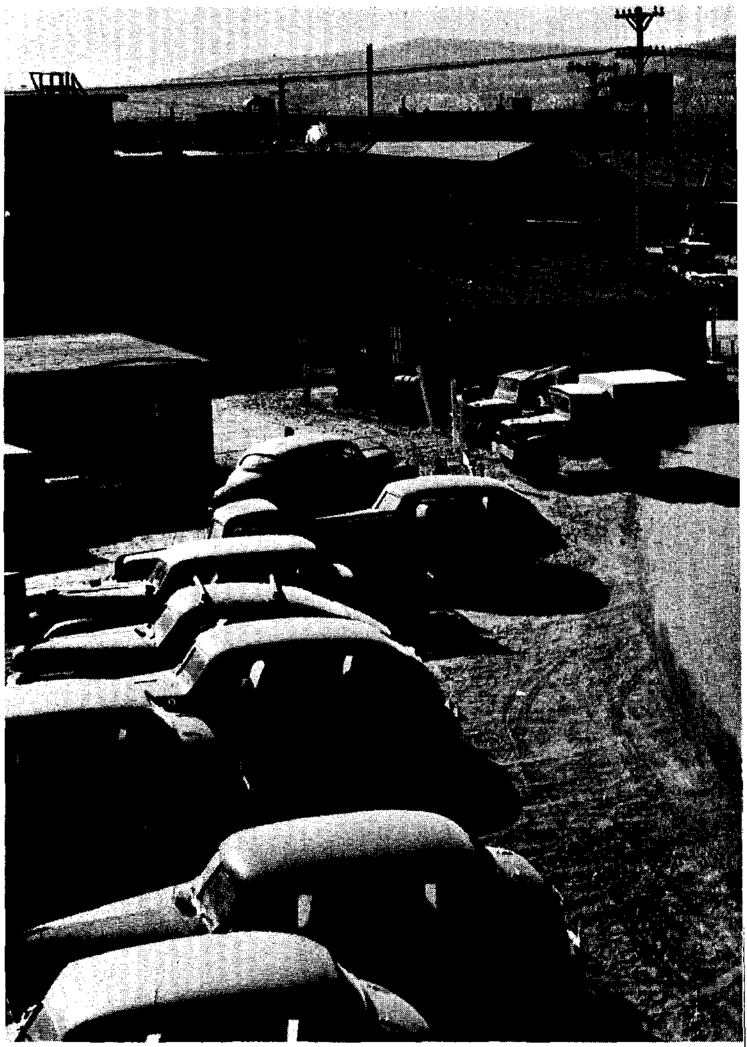
- Columbia University
- Princeton University
- The Standard Oil Development Company
- Purdue University
- The University of Wisconsin
- Stanford University
- The University of Indiana
- Rice Institute
- Cornell University
- The Carnegie Institution of Washington
- The University of Minnesota
- Iowa State College
- Johns Hopkins University
- The National Bureau of Standards
- The University of Virginia
- The University of Chicago
- The University of California
- Washington University (St. Louis)
- Massachusetts Institute of Technology.

By early 1943, when Los Alamos became the focal point of nuclear weapon research and development, a great deal had been learned about the chemistry and physics of uranium (U) and plutonium (Pu). Much more, however, remained to be discovered.

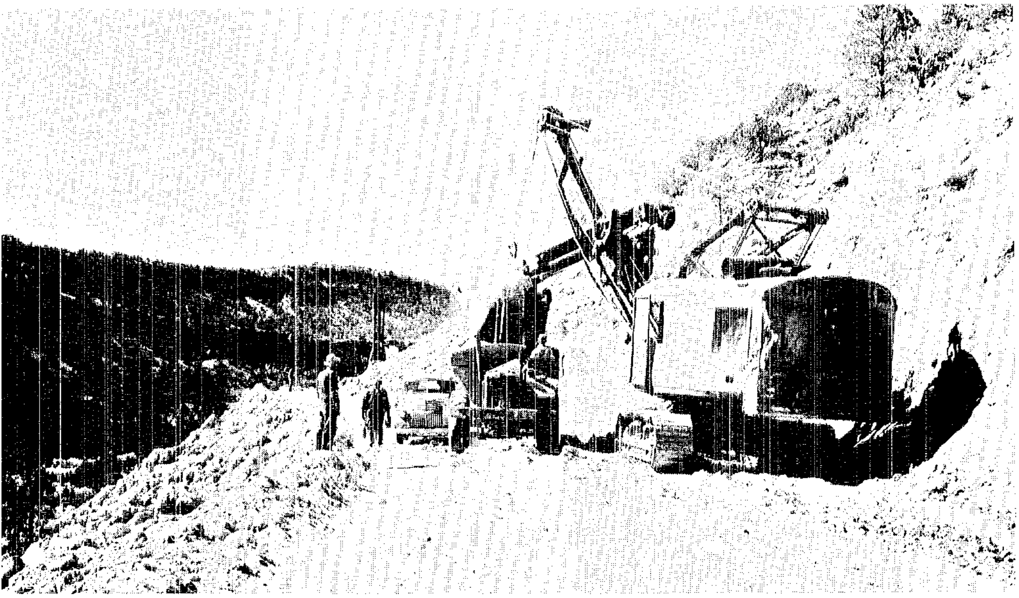
The Los Alamos Laboratory (it would not be known as "Los Alamos Scientific Laboratory" until January, 1947) was founded at the beginning of 1943. Its operating contractor, then as now, was the University of California. Its mission was to create atomic bombs. This meant not only research and development, but fabrication of actual weapons for possible use in the war.

Within the first months of its life, the Laboratory began research projects aimed at finding answers to a variety of questions about uranium and plutonium:

How many neutrons, on the average, are emitted



Los Alamos scientists launched their research projects early in 1943 in a makeshift laboratory which quickly grew into this sprawling technical area.



Far left: There was never enough housing for the mushrooming Los Alamos population and much of it was makeshift and temporary. Near left: In October 1943 major road improvements were underway on State Road 4 to carry the heavy traffic in personnel and equipment to and from Los Alamos.

per fission in U-235 and Pu-239? (In the case of plutonium, the experiments had to be performed with a sample visible to the naked eye.)

How fast are the neutrons traveling when they are emitted?

How likely are neutrons of high, low, and all intermediate speeds to cause fission in U-235 and in Pu-239?

How long a time (meaning what fraction of a millionth of a second) elapses between fission and the emission of virtually all the fission neutrons?

Would some compound like uranium hydride have advantages over metallic uranium as a bomb fuel?

What are the best purification processes for uranium and plutonium, and what analytical methods will best measure small amounts of impurities in the two materials?

Those were the main unanswered questions about the core materials. (Many research problems about other matters connected with the bomb had to be tackled during the same period, and will be discussed in a later section.)

Unique experimental techniques were devised to produce and count neutrons of specific energies (speeds), to measure fission in various materials, and to measure non-fission reactions induced by neutrons. Ways of preparing plutonium and uranium metals of unprecedented purity were developed, together with suitable special methods of machining and fabrication.

The mysteries that had previously surrounded the chemistry, physics, and metallurgy of the core materials were beginning to be solved.

In Los Alamos by day great minds pondered the bomb problems, by night, talk turned to less secret discussions. From left to right across both pages: Enrico Fermi with L. D. P. King; Eric Jette, Charles Critchfield, J. Robert Oppenheimer; Edward Teller with Norris Bradbury; E. O. Lawrence, Fermi and I. I. Rabi.

designing the bomb

The problems of bomb design were still formidable. Even if the core materials could be delivered to Los Alamos in time (and sufficiently purified there), and even if they could be shown to be capable of supporting a chain reaction (no longer a big if), the most important question remained. How does one use plutonium or uranium in such a way as to produce an efficient explosion?

It was clear that almost any chain-reacting system could be caused to overheat, and perhaps even to blow itself apart. If that had been the only requirement, there would have been no problem.

For military effectiveness, a mere "runaway chain reaction" would not do. Such a reaction would release hardly more energy than would suffice to disrupt the materials in which it occurred. What was needed was a device that would release a great deal of energy almost instantaneously, so that the reaction could proceed a long way toward completion before being quenched by the dispersal of the fissionable material.

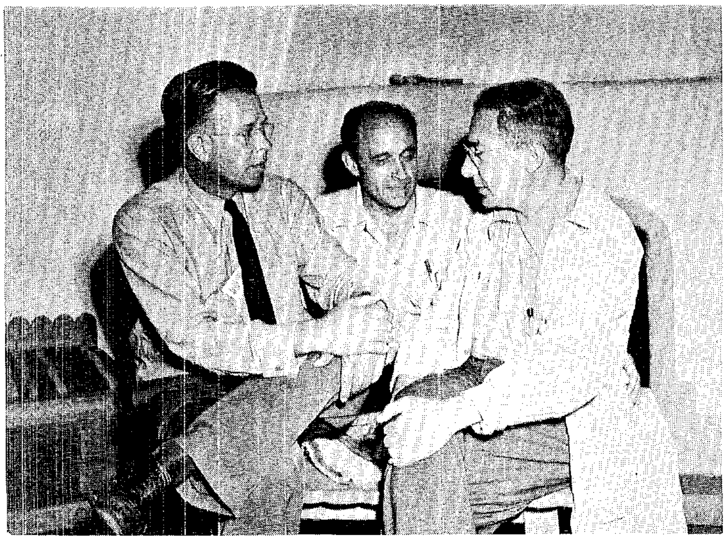
One of the requirements for such a device became obvious very early in the program: The fission chain would have to be sustained by *fast* neutrons. Even if military considerations had not dictated that the bomb be as compact as possible (which they did), the inclusion of moderating material to slow the neutrons would result in a reaction too slow for efficiency.

Another requirement was speed of assembly. As the core passed from its subcritical, or safe, configuration to its supercritical, or explosive, configuration, it would inevitably pass through configurations that were barely critical. Fast assembly would be necessary to prevent the reaction from beginning too soon, before the optimum configuration could be reached.

For the sake of explosion efficiency, it was inadvisable to depend on "background" neutrons (free neutrons unavoidably present in the bomb at all times) to start the reaction. The only way to be sure the reaction would start fast, and at exactly the right moment, was to arrange an internal neutron source that would deliver millions of neutrons in a single burst at the instant of complete assembly. Devices called "initiators" had to be developed to supply these neutrons.

A fourth requirement would be an envelope of some heavy material around the core. This envelope (called a tamper) was necessary both to reflect escaping neutrons back into the core and—much more important—to retard the expansion of the core as much as possible, so that the critical configuration could be preserved a little longer, permitting more fissions before the bomb blew itself apart.

All four of these requirements, and a number of others, had to be met before an efficient explosion could be produced. This meant not just engineering, but additional fundamental research. Knowledge had to be gained about the feasibility of a chain reaction with fast neutrons, about the amount of fissionable material that would constitute a fissionable mass in various geometries, about the possible neutron-producing reactions that might be



useful in an initiator, and about the nuclear characteristics of possible tamper materials. A tremendous mathematical effort had to be devoted to calculations related to the physics and thermodynamics of the bomb.

And, since no assembly method would be fast enough unless it made use of high explosives, an intensive study of the potentialities of chemical explosives for this purpose had to be made.

In principle, two general methods of assembly appeared possible. One was the so-called "gun" method, in which one subcritical mass of fissionable material would be fired as a projectile at a target consisting of another subcritical mass of fissionable material. When projectile met target, the two together would constitute a supercritical mass. (The gun, with its explosive charge and its fissionable projectile, would have to be enclosed in the bomb casing, along with the target.) The other assembly method was "implosion," in which a slightly subcritical mass of fissionable material would be surrounded by high explosives. When these explosives were detonated, they would compress the fissionable material, thereby increasing its density (decreasing the distances between target nuclei), thus rendering it supercritical.

The gun method appeared to be the easier to develop. It involved principles already well understood by ordnance experts, while the implosion method introduced entirely new principles of guiding explosive energy. Until 1944, it was hoped that the gun method might work for both uranium and plutonium bombs. It was a somewhat slower detonation system than implosion was, but its development would require fewer technological innovations.

In 1944 came the verification of a piece of bad news rumored a little earlier: The gun method was unsuitable for plutonium bombs. The reason was that plutonium produced in nuclear reactors (such as those at Oak Ridge and Hanford) contained a significant percentage of an isotope identified as Pu-240. Plutonium of this mass number had a strong tendency toward spontaneous fission, releasing neutrons. This produced an unusually high neutron background in plutonium containing the 240 isotope. Therefore, assembly of a plutonium bomb would have to be lightning-fast to prevent premature initiation of the chain reaction. Assembly by the gun method would be too slow; in a plutonium bomb, it would have to be implosion or nothing.

With the discovery of Pu-240, Los Alamos scientists and engineers increased their efforts to solve the problems of implosion. Meanwhile, the gun method was being perfected for use in a uranium bomb.

The simplest way to proceed might have been to build a few experimental bombs in the early nineteen-forties and try them out. Not the least of the Laboratory's problems arose from the impossibility of doing this. By the time the precious shipments of fissionable material arrived at Los Alamos, a workable bomb design had to be ready. Various components and sub-assemblies could be tested by themselves, but no integral test of the weapon would be possible until long after the time when such testing might have served its purpose best.

In spite of these difficulties and others, the designs were created. By means of a combination of theoretical and experimental work, of pure science and nuts-and-bolts engineering, both the uranium and the plutonium bomb were brought to readiness soon after the middle of 1945.

Neither, however, had ever been tried.

Not until July 16, 1945.

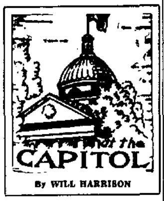
SANTA FE NEW MEXICAN

The Oldest Newspaper in the Southwest, Founded in 1849

Vol. 96, No. 313 | MEMBER AUDIT BUREAU OF CIRCULATIONS | SANTA FE, NEW MEXICO, MONDAY, AUGUST 6, 1945 | ASSOCIATED PRESS UNITED PRESS | Price 5c

Los Alamos Secret Disclosed by Truman

ATOMIC BOMBS DROP ON JAPAN



By WILL HARRISON

Last week's "Big I" handout from the Governor's office was today still reverberating in educational and legislative circles.

Governor Dempsey was quoted in the news handout as saying:

"During the 1943 Legislature I sponsored a bill which transferred all of the mineral leasing act funds, except that portion used for free textbooks and the Bureau of Mines, to the school equalization fund."

The act, in two years, has produced $1,165,173 for the school equalization fund.

Comes today a letter from Sen. J. H. Mullis of Roswell:

"Before the 1943 Legislature I conferred with J. D. Shinkle, superintendent of the Roswell schools, Col. E. L. Lusk of the New Mexico Military Institute, and Clarence E. Hinkle, president of the Roswell board of education, regarding legislation which would increase the teachers' salaries. We decided on three bills:

"1.—To transfer to the school fund, to be used to increase the teachers' salaries, the balance of the Mineral Leasing Act fund, mentioned by Governor Dempsey;

"2.—Reducing from 5 per cent to 3 per cent the amount allowed the Bureau of Revenue for collecting the sales tax;

"3.—Limiting the Commissioner of Public Lands to $100,000 per year.

"I had these bills prepared before the Legislature convened and Governor Dempsey had nothing to do with the preparation of these bills. It is my recollection that Governor Dempsey was opposed to the mineral funds bill because it took that amount from the general fund.

"I introduced the bills and with the help of the New Mexico Educational Association secured the passage of the first but the Governor had the other two killed."

As noted in this space Saturday, the teachers act which the Governor said "I sponsored" was permitted to pass only after the school lobby consented to support a Dempsey measure permitting the transfer of certain surplus administrative funds to the state general fund.

And after the "I sponsored bill" became law the administration even then tried to grab part of the mineral leasing money for other than school support. Nov. 20, 1943, state records show, Governor Dempsey's State Board of Finance ordered $85,612.16 of mineral leasing money transferred to the general fund. Educational groups put up a fight and on Nov. 29, 1943, the amount was returned on the authority of an Attorney General's opinion

Although the schools received during the past two years $1,165,173 as a result of the "I sponsored bill" a complete and truthful statement would show that funds almost equalling that amount were taken from the schools by Dempsey sponsored bills in the same Legislature that enacted the mineral leasing funds law.

The transfer law, for which Dempsey traded with the school lobby, in the past two years has taken $357,593.64 for the general fund that would otherwise have gone to schools. ($163,106.71 from surplus in emergency school tax administrative fund in 1945, and $95,000 in 1944; $69,486.93 from surplus in income tax administration fund in 1945, and $30,000 in 1944.)

A total of $514,000 from the Casual Indebtedness fund was transferred to the general fund when no deficit existed. This money, under administrations prior to Dempsey, would have been transferred to the schools as witnessed June 30, 1943, when Gov. John Miles transferred to the schools $145,761.24 of casual deficit funds which were not needed to meet actual deficits.

The transfers under Dempsey of casual deficit money to the state general fund were $262,000 in 1944 and $252,000 in 1945.

Net Gain $283,580

The sum of these losses to school funds is $871,593.64, leaving a net gain through the mineral leasing funds law of $283,580.

And that gain may be credited to Sen. J. H. Mullis of Roswell and the New Mexico Educational Association who first fought the administration and then traded out with the Governor for the increased revenue.

$100 STOLEN

Mrs. Ida M. Glynn, living in one of La Posada's cabins, reported to city police that $100 was stolen from a purse which she had hidden under a pillow in one of her rooms. The money included a $50 bill, police said.

Deadliest Weapons in World's History Made In Santa Fe Vicinity

Santa Fe learned officially today of a city of 6,000 in its own front yard.

The reverberating announcement of the Los Alamos bomb, with 2,000 times the power of the great Grand-Slammers dropped on Germany, also lifted the secret of the community on the Pajarito Plateau, whose presence Santa Fe has ignored, except in whispers, for more than two years.

Decision to locate the Atomic Bomb Project Laboratory on mesa an hour's drive from Santa Fe, meant that it was necessary for the Army Engineers to construct an entirely new town to house the workers and their families. Primary reason for selection of the isolated site was security.

Ranch School Site

When the Army took over the property early in 1943 there were a few buildings which had been occupied by the Los Alamos Ranch School. New buildings began going up at once. Today there are 37 in the main technical area and about 300 others on the property used for the project itself. Three hundred buildings containing 620 family units, also were constructed, as well as military barracks, hospital buildings and structures for administrative offices.

Dr. J. R. Oppenheimer, one of the foremost physicists in the country and director of the laboratory, came to the site during early stages of construction. Other scientists and technical workers followed soon after.

Scientific groups which had been working on the project elsewhere in the country moved in rapidly, bringing their equipment with them. The Harvard cyclotron was in operation six weeks after it had reached the site.

Tortuous Route

Nearest railroad facilities are at Albuquerque and Santa Fe. This made it necessary to truck everything from those cities, at least. The road from Santa Fe is a tortuous one, and in the beginning, the last 18 miles were not paved. This was bad enough for passenger cars, and presented a particularly tough problem in hauling heavy loads.

Today the community has more than 6,000 residents. Slightly less than two-thirds are civilian men, women and children and the remainder military personnel. The post commandant is Col. Gerald R. Tyler.

First need of arriving personnel in mess halls, or in a large cafeteria. was housing. Various types were constructed, to meet different needs. There are three-room prefabricated, individual houses; three-room apartments, eight to a building, and four- and five-room apartments, four in a two-story unit. There are some hutments, Quonset-type huts and government and personally-owned trailers.

Bachelor Dorms

Dormitories have been constructed for unmarried personnel, or persons who do not have their families with them. Rents, for family groups, are based on earnings. Apartments are unfurnished and family groups ordinarily bring their furniture with them, although some items of government furniture have been available.

Housewives shop for food for daily meals at an army commissary where ration points are as important as elsewhere. A "trading post" offers items needed in everyday life and there are the usual post exchange stores.

Personnel living in dormitories eat There is also a dining room with waitress service.

City Dads, Too

A "town council" of eight elected members serves in an advisory capacity, meeting with representatives of the project and of the commanding officer. There is a school board, appointed by Colonel Tyler, and Doctor Oppenheimer, which oversees operation of an accredited elementary school and high school. There

(Continued on Back Page)

REVOLUTIONARY

News of the development of an atomic bomb immediately raised conjecture regarding the potential industrial uses of the energy.

The power of the atomic force harnessed by scientists in the secret projects is almost beyond comprehension—one bomb packing the wallop of the bomb loads of 2,000 Superforts. Talk was at once heard of the possibility of the newly controlled energy replacing coal, electricity, gasoline, water as a source of power.

That the study of the subject will continue was assured by the appointment by the Secretary of War of a committee to carry on investigation of atomic energy.

Spokesmen for the Los Alamos project said they had not been informed if this meant post-war continuation of the mountain project.

TERRITORIAL CHANGES OF WORLD WAR II—Black areas on map are those parts of Germany which the Big Three proposes will come under Polish rule. Shaded area is territory which Russia has taken control over since the start of hostilities on the continent. Northern East Prussia, proposed as Russian by the Big Three, is the newest addition to Soviet territory. There still remains some question as to final disposition of the port of Stettin. Note the large section of Baltic coastline of the proposed new Poland.

4 More Nippon Cities Now Smoldering Ruins

By The Associated Press

American airmen said they turned four more forewarned Japanese cities to ashes today as 580 Superforts and Mustang fighters reportedly swept the enemy's sacred islands with fire bombs, rockets and parachuted mines.

B-29 crewmen returning to their Marianas Island bases told of setting fires visible for 150 miles at sea. Some ran into intense antiaircraft fire and strong interception including rocket planes as they raided cities Tokyo described as "defenseless".

Waves of B-29s from the Marianas Islands and Mustang fighters from Iwo Jima struck as American commanders announced 70 Nipponese ships and small craft and 61 locomotives were destroyed or damaged in previous aerial blows, reaching over 4,500 miles from Paramushiro to Singapore.

Terror-ridden China carried the brunt of ground actions. Elsewhere land armies hunted for Japanese generals in the northern Philippines, drove toward trapping the largest Japanese force remaining in New Guinea and counted 13,000 Nipponese dead in recent fighting in monsoon-swept south Burma.

Superforts warned 12 more cities Sunday morning they were on their fire list. A formation of 580 followed up today by lighting towering fires in four of the 31 forewarned cities.

Today's targets include Nishinomiya, noted in prewar days for producing Japan's best sake, favorite alcoholic beverage of Nippon. The other industrial targets were Maebashi, 80 miles from Tokyo, saga on northern Honshu Island, and Imbari, on the southern island of Honshu. One B-29 unit hammered the Ube coal liquefaction plant with high explosives.

Japanese also reported Mustangs from Iwo raked the capital with rockets, bombs and machinegun bullets in daylight for the third time in four days.

For consolation, Japanese propagandists reported: Americans "lead a starvation life;" Nipponese raiders caught U. S. planes lined up wing to wing on two Okinawa air fields; a U. S. submarine was sunk off the coast of Japan; Nipponese subs sank two Allied vessels in the central Pacific.

Chinese reports told of new terror in China. Once-beautiful Kweilin, former southeast China air base city, was left thoroughly sacked. Fifty-thousand Chinese were killed or missing from Kanhsien in east central China. A thousand civilians were reported killed by forced poisonous injections at Ichang, enemy-held central China river port.

Americans and Filipinos eliminated an ambushing Japanese company and beat back two desperate counterattacks on northern Luzon island, running last week's toll in the Philippines to 4,740 Japanese killed and 444 taken prisoner. U. S. losses for the week were 27 killed, 61 wounded.

Maj. Gen. William Gill offered a 45-day furlough to any member of the 32d Division who captures an enemy general alive. Chief prize is Gen. Tomoyuki Yamashita, onetime "Tiger of Malaya" variously reported cornered, killed or flown from northern Luzon mountains.

Hi Johnson Dies at 79

WASHINGTON, Aug. 6 (AP)—Sen. Hiram W. Johnson of California, militant opponent of the League of Nations and the San Francisco Charter for a United Nations organization, died today.

The veteran Republican senator succumbed at Naval Hospital, where he had been confined for 2½ weeks. His physician, Capt. Robert E. Duncan, USN, said he died from a thrombosis of a cerebral artery.

The 79-year-old Californian died at 6:45 a. m., after having been in ill health for some time.

His political activities extended over a third of a century covering some of the most stirring events in the nations history.

A striking figure in the Senate since first elected to Congress in 1916, he played a leading part in defeating President Wilson's League of Nations Covenant and later in opposing United States' adherence to the World Court.

His wife, whom he referred to as "the boss," was with him at the time of his death.

Senator McKellar (D.-Tenn.), President of the Senate, today will appoint a committee to attend the funeral of the silver-haired veteran.

'Utter Destruction,' Promised in Potsdam Ultimatum, Unleashed; Power Equals 2,000 Superforts

WASHINGTON, Aug. 6 (AP)—The U. S. Army Air Force has released on the Japanese an atomic bomb containing more power than 20,000 tons of TNT.

It produces more than 2,000 times the blast of the largest bomb ever used before.

The announcement of the development was made in a statement by President Truman released by the White House today.

The bomb was dropped 16 hours ago on Hiroshima, an important Japanese army base.

The President said that the bomb has "added a new and revolutionary increase in destruction" on the Japanese.

Mr. Truman added:

"It is an atomic bomb. It is a harnessing of the basic power of the universe. The force from which the sun draws its power has been loosed against those who brought war to the Far East."

The base that was hit is a major quartermaster depot and has large ordnance, machine tool and aircraft plants.

The raid on Hiroshima, located on Honshu Island on the shores of the Inland sea, had not been disclosed previously although the 20th Air Force on Guam announced that 580 Superforts raided four Japanese cities at about the same time.

The city of 318,000 also contains a principal port.

2 Billion Gamble

The President disclosed that the Germans "worked feverishly" in search of a way to use atomic energy in their war effort but failed. Meantime American and British scientists studied the problem and developed two principal plants and some lesser factories for the production of atomic power.

The President disclosed that more than 65,000 persons now are working in great secrecy in these plants, adding:

"We have spent $2,000,000,000 on the greatest scientific gamble in history — and won."

"We are now prepared to obliterate more rapidly and completely every productive enterprise the Japanese have above ground in any city. We shall completely destroy Japan's power to make war."

The President noted that the Big Three ultimatum issued July 26 at Potsdam was intended "to spare the Japanese people from utter destruction" and the Japanese leaders rejected it. The atomic bomb now is the answer to that rejection and the President said "they may expect a rain of ruin from the air, the like of which has never been seen on this earth."

Process Secret

Mr. Truman forecast that sea and land forces will follow up this air attack in such numbers and power as the Japanese never have witnessed.

The President said that this discovery may open the war for an entirely new concept of force and power. The actual harnessing of atomic energy may in the future supply the power that now comes from coal, oil and the great dams, he said.

"It has never been the habit of the scientists of this country or the policy of this government to withhold from the world scientific knowledge," Mr. Truman said. "Normally therefore everything about the work with atomic energy would be made public." That will have to wait, however, he said, until the war emergency is over.

MADE IN SANTA FE

WASHINGTON, Aug. 6 (AP)—The atomic bomb disclosed by President Truman today was developed at factories in Tennessee, Washington and New Mexico.

Mr. Truman said that from 65,000 to 125,000 workers were employed on the project at Oak Ridge near Knoxville, Tenn., at Richland near Pasco, Wash., and at an unnamed installation near Santa Fe, New Mexico.

He said the work was so secret that most of the employes did not know the character of it.

WILL SHORTEN WAR

WASHINGTON, Aug. 6 (AP) — Secretary Stimson predicted today that the atomic bomb will "prove a tremendous aid" in shortening the war with Japan.

The war secretary made his statement as the Army reported that an "impenetrable cloud of dust and smoke" cloaked Hiroshima after it was hit by the new weapon from the air.

An accurate assessment of the damage inflicted by the bomb is not yet available, however, the War Department said. As soon as details of its effectiveness are learned, the department added, they will be released.

PUNCH CATASTROPHIC

WASHINGTON, Aug. 6 (AP) — The atomic bomb announced by President Truman today packs a punch equivalent to that normally delivered by 2,000 B-29s.

The President said the missile has an explosive force equal to 20,000 tons—40,000,000 pounds—of TNT. Assuming a B-29 carries a bomb load of 10 tons of TNT, four 500-plane raids by the world's biggest bombers would be necessary to equal in destructive power the exploding fury of one atomic bomb.

The atomic bomb dwarfs by 2,000 times the blast power of the British "grand-slam" bomb, which weighed approximately 11 tons.

LONDON, Aug. 6 (AP)—Germany possessed some atomic power secrets, Winston Churchill said tonight, but "by God's mercy, British and American science outpaced all German efforts."

Tomato Juice Off Rationing

WASHINGTON, Aug. 6 (AP)—Grocers scratched point values today from canned tomato juice, mixed vegetable juice and grapefruit-orange juice blends.

OPA's action in making those products ration-free yesterday followed a recommendation from Secretary of Agriculture Anderson based on lowered military demands.

Anderson also announced that civilian store shelves will get 10,000,000 more cases of canned vegetables from this year's pack than had been expected.

Despite the 10 per cent increase, however, the Agriculture Department said the total still will be less than last year's.

SENTENCED

Pat Chavez, 333 Urioste Street, faced a 100-day jail sentence and $100 fine today on conviction before Peace Justice A. E. P. Robinson of assault and battery on a woman taxi driver. The court reported the case Saturday as involving a Pat Lopez and called attention today to the correct name of the defendant.

May Be Tool To End Wars; New Era Seen

Mankind's successful transition to a new age, the Atomic Age, was ushered in July 16, 1945, before the eyes of a tense group of renowned scientists and military men gathered in the desertlands of New Mexico to witness the first hand results of their $2,000,000,000 effort. Here in a remote section of the Alamogordo Air Base 120 miles southeast of Albuquerque the first man-made atomic explosion, the outstanding achievement of nuclear science, was achieved at 5:30 a. m. of that day.

Mounted on a steel tower, a revolutionary weapon destined to change war as it has been known, or which may even be the instrumentality to end all wars, was set off with an impact which signalized man's entrance into a new physical world. Success was greater than the most ambitious estimates. A small amount of matter, the product of a chain of huge specially constructed industrial plants, was made to release the energy of the universe locked up within the atom from the beginning of time.

Credit J. R. Oppenheimer

This phase of the Atomic Bomb Project, which is headed by Maj. Gen. Leslie R. Groves, was under the direction of Dr. J. R. Oppenheimer, theoretical physicist of the University of California. He is to be credited with achieving the implementation of atomic energy for military purposes.

Tension before the actual detonation was at a tremendous pitch. Failure was an ever-present possibility. Too great a success, envisioned by some of those present, might have meant an uncontrollable, unusable weapon.

Final assembly of the atomic bomb began on the night of July 12 in an old ranch house. As various component assemblies arrived from distant points, tension among the scientists rose to an increasing pitch. Coolest of all was the man charged with the actual assembly of the vital core, Dr. R. F. Bacher, in normal times a professor at Cornell University.

Lightning Threatens

On Saturday, July 14, the unit which was to determine the success or failure of the entire project was elevated to the top of the steel tower.

The ominous weather which had dogged the assembly of the bomb had a very sobering effect on the assembled experts whose work was accomplished amid lightning flashes and peals of thunder.

Nearest observation point was set up 10,000 yards south of the tower where in a timber and earth shelter the controls for the tests were located. At a point 17,000 yards from the tower at a point which would give the best observation the key figures in the atomic bomb project took their posts. These included General Groves, Dr. Vannevar Bush, head of the Office of Scientific Research and Development, and Dr. James B. Conant, president of Harvard University.

Lie Face Down

Actual detonation was in charge of Dr. K. T. Bainbridge of Massachusetts Institute of Technology. He and Lieutenant Bush, in charge of the Military Police Detachment, were the last men to inspect the tower with its cosmic bomb.

At the Base Camp, all present were ordered to lie on the ground, face downward, heads away from the blast direction.

Tension reached a tremendous pitch in the control room as the deadline approached. The several observation points in the area were tied in to the control room by radio and with 20 minutes to go, Dr. S. K. Allison of Chicago University took

(Continued on Back Page)

The Weather

New Mexico: Partly cloudy with widely scattered thunderstorms mostly over mountains during afternoon and evening; otherwise fair tonight and tomorrow; no important change in temperature.

City
High 90, low 56.
Airport
High 82, low 62.

Now They Can Be Told Aloud, Those Stoories of 'the Hill'

By WILLIAM McNULTY

The secret of Los Alamos is out and The New Mexican staff and other newspapermen through New Mexico can heave a sigh—sigh, nothing; it's more of a groan—of relief.

President Truman's revelation today that it was an atomic bomb THEY were working on on The Hill ended what was probably the strictest censorship ever imposed upon the press of this state. There was practically no limit to the lengths that the guards went to and the situation at times became fantastically involved including the famed "Battle of the MPs."

Notwithstanding the censorship, the news of Los Alamos had scarcely raced about the Plaza this morning when the membership of the "I-Knew-It-All-Along" club began growing by leaps and bounds. As a matter of record, the most recent rumor, No. 6,892—straight from the horse's mouth last week—was that Alamos was working tickety-split, night and day, in the production of windshield wipers for submarines.

The taboo on the mention of Los Alamos was final, complete and until today, irrevocable and not susceptible to any exceptions whatsoever.

A whole social world existed in nowhere in which people were married and babies were born nowhere. People died in a vacuum, autos and trucks crashed in a vacuum and the MPs baseball team materialized out of a vacuum, trained in a vacuum and after their games at Fort Marcy Park, returned to the vacuum. Even the graduates of Los Alamos Ranch School, the institution which preceded Uncle Sam's Atomic Bomb Project Laboratory, ceased to be graduates of Los Alamos; they bounded direct from Public School No. 7 clear into the classrooms of Harvard and Yale.

And on days when the Alamos experimenters threw their atomic bombs about a little too vigorously and the windows of Santa Fe rattled ominously, this paper's phones would ring but the whole staff could just "no speak English".

The chain of secrecy about the project was maintained from the big cities in East where workers were recruited clear through to the delivery of these same workers on The Hill. The Alamos Bus stop was at Sena Plaza and people laden with luggage and youngsters clinging to their arms, frequently barged into offices of that Plaza and inquired, "Where do we go to work?" One of the earliest bits of Alamos lore was that of the dude who had never been farther west than Albany, N. Y.; she chose the moment when The Hill bus was turning the highest point on the Jemez mountains to peek out—and fainted dead away.

Under these conditions of secrecy rumors multiplied like maggots in one of Mel Hagman's garbage cans. Gas warfare, rockets, jet propulsion, death rays and — atomic bombs — were among the guesses most frequently voiced. During the last Presidential campaign, Alamos—no foolin'—was sometimes a Republican internment camp.

In the early days of the project, even the "outside employes" who knew no more of what was going on than the Japs in the foxholes of Guadalcanal, were sworn never to reveal what they didn't know anything. For the sake of their lifetime, Our own B. B. Dunne got tangled in the wringer for so much as mentioning that "there were a lot of scientists in town".

Then there was the time when the New York Daily was whipping up a Sunday feature on Nobel prize-winners in the U. S. It queried The New Mexican for a brief summary of what Prof X was doing now. The staff recognized the Alamos postoffice box number—that famous postal box where babies were born and to which whole trainloads of furniture assigned—but it was decided to give the professor a whirl anyway on the old "You can't shoot me for trying" principle. A letter went out to Professor X in which an interview was asked.

The next morning at 8:09—their watches must have been slow,—two guards jumped the cityroom. After a heap of protestations and avowals of innocence, it was agreed that the following telegram could be sent the News:

"Your man working for Mr Whiskers on extremely hush-hush project. No soap.".

The telegram was delivered in New York by a Western Union boy flanked by a covey of guards. These men then began spilling all over the News cityroom like oranges out of a busted crate.

How, they wanted to know, did the News staff explain such Dick Tracy huggermugger stuff?

The News' difficulty was that the girl who had sent the telegram had gone on vacation and couldn't be reached. The News explained it after two clouded weeks in which, by report, you couldn't toss a cigaret in a wastepaper basket without setting fire to a guard.

The tantalizing little that Santa Feans knew about The Hill, only heightened their interest. There were the lights to be seen from miles away; there were the days when fires raged and smoked billowed in the mountains and always the mysterious explosions — (Lady Holmes moved to Tesuque and had moments when she thought she was back in bomb-shattered London)

The payoff, however, came in the "Battle of the MPs". More than a year ago a boxing card was arranged in which the Santa Fe High athletes took on the Alamos MPs. The sluggers from The Hill must have been missing out on their vitamins or the Demons were packing an atomic punch because the MPs were knocked cold, two or three of them in one round and one punch practically.

Unfortunately for Mel Rhine and his Santa Fe MPs—as distinct from the Alamos MPs—soldiers read the sports pages and the next Saturday night, there was an epidemic of free-swinging in the bars and restaurants.

Frantically Rhine demanded that The New Mexican print an explanation that the one-round pushovers were decidedly NOT his MPs but he ran smack into the Alamos censorship ban.

For hours Rhine sweated over a document which, by the time it complied with censorship requirements, rambled for no less than 700 words or so—and meant exactly nothing to anybody. It was a masterpiece of obfuscation. Of course, the boys were still swinging at the so-called "one-round MPs" for weeks before they discovered their mistake.

after trinity

There never had been much doubt that the gun-type uranium weapon would work. By July 14, two days before the implosion weapon was tested, the major portion of the U-235 component began its journey overseas from Los Alamos. A few hours before dawn on July 16, just as observers in the Jornada del Muerto were witnessing the incredible birth of the atomic age, the uranium bomb was hoisted aboard the cruiser Indianapolis at San Francisco.

At Potsdam, where President Truman and Prime Minister Churchill were waiting to meet with Stalin to discuss a demand for unconditional surrender from the Japanese, the news of the successful test of the Fat Man that morning had a profound effect. Confidence in the test results and the reassurance that the first bomb could be ready for delivery on July 31 froze the previously tentative decision that the time had come to issue the surrender ultimatum. The atomic bomb had made invasion unnecessary and could provide the Japanese with an honorable excuse to surrender. The war could end quickly. There was no longer any need for help from Russia. Churchill and Truman approached the talks in extreme confidence.

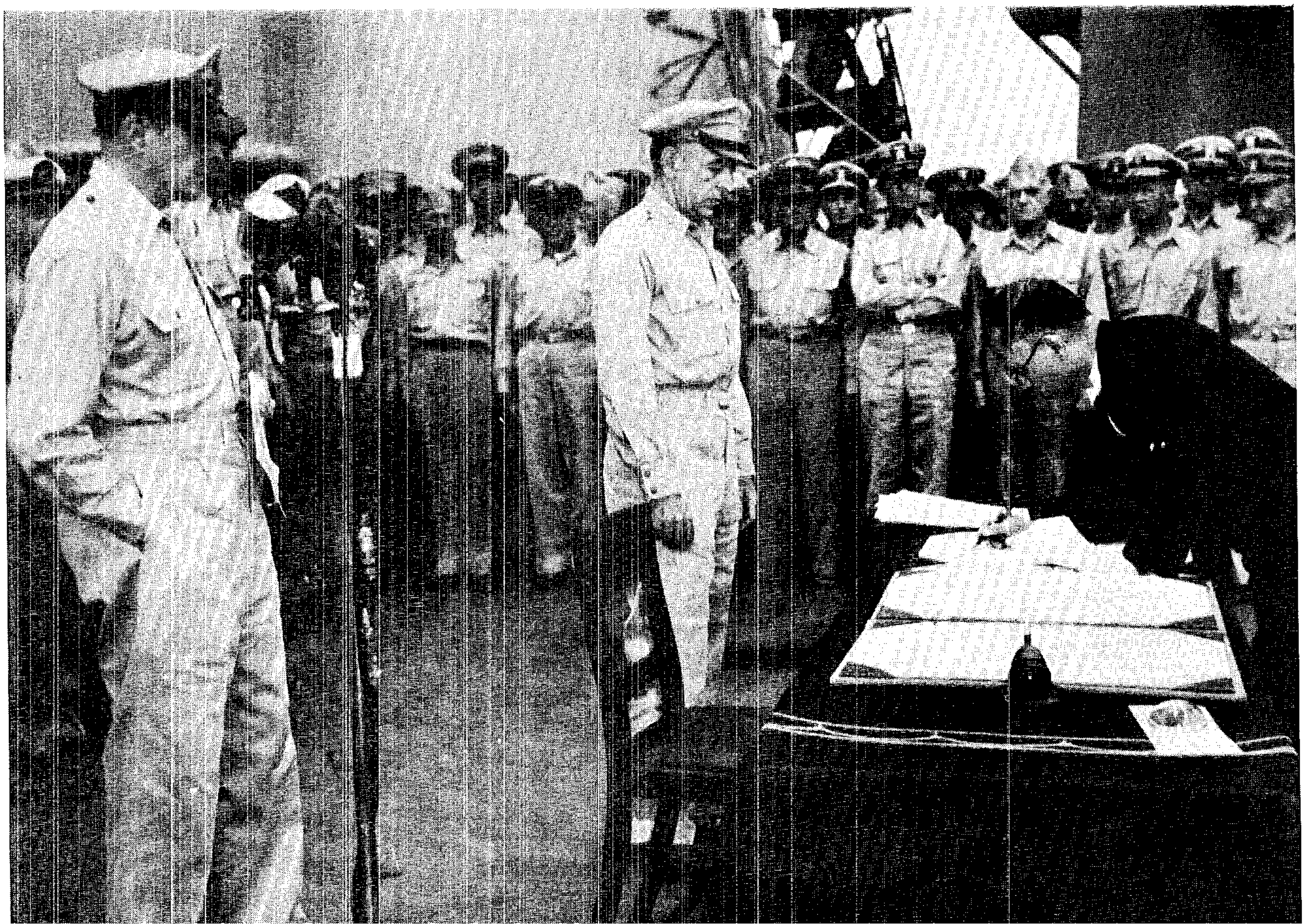
On July 26, the Indianapolis arrived at Tinian and two nights later transport planes arrived with the last necessary bit of U-235 and the uranium device was ready.

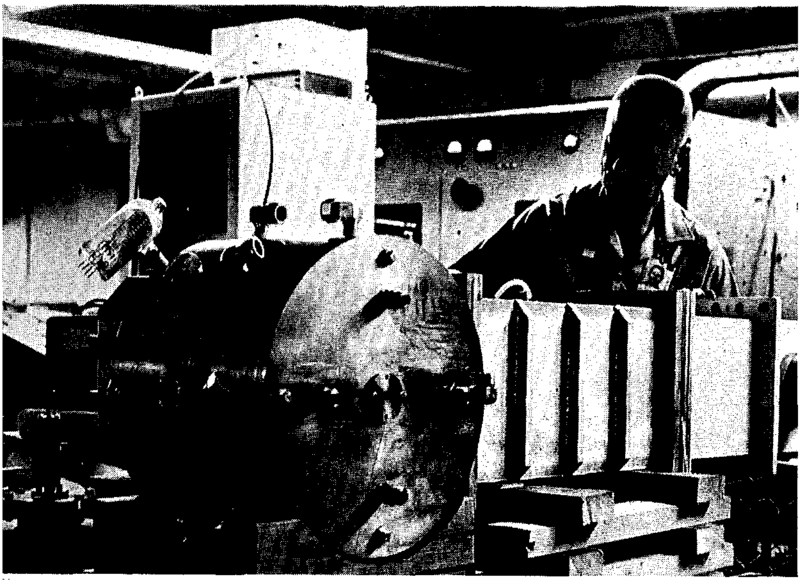
The world's second man-made nuclear explosion occurred over Hiroshima, Japan, on August 6, three weeks after the Trinity test. On August 9, the third such explosion devastated the city of Nagasaki, Japan gave up the struggle five days later, and formal surrender ceremonies were held September 2.

Though no nuclear weapon has been used in war since that time, the development of new kinds of nuclear weapons has gone on. In November, 1952, observers at the AEC's Eniwetok Proving Ground witnessed a test detonation almost as historic as the one in New Mexico in 1945. A Los Alamos device called "Mike" produced the world's first full-scale thermonuclear explosion.

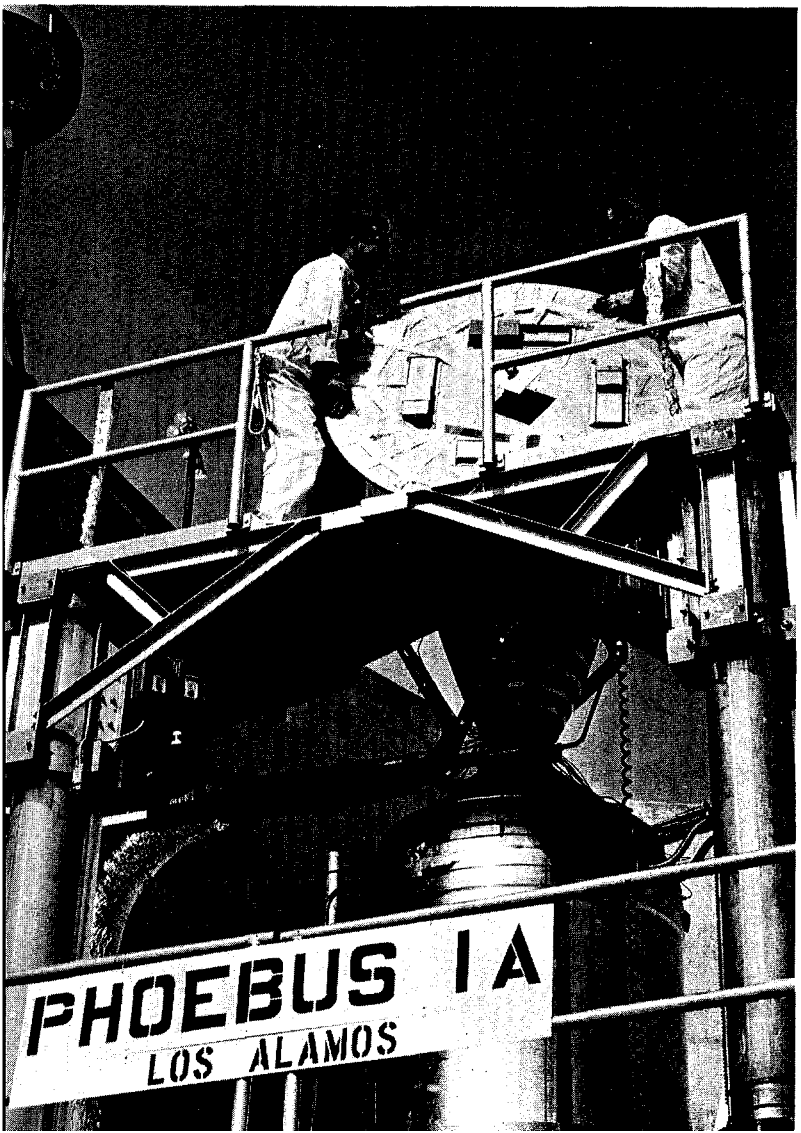
In a thermonuclear bomb, the energy-liberating process is quite unlike nuclear fission. What happens is that very *light* nuclei, such as hydrogen (instead of very heavy ones, as in fission devices) are combined to form heavier nuclei (instead of being

General Douglas MacArthur watches as the Japanese foreign minister signs the surrender document aboard the U.S.S. Missouri on September 2, 1945.





Construction of a linear accelerator for a broad program of meson research has been proposed for Los Alamos. Meanwhile, design, prototype fabrication and testing of each component for the facility is being undertaken. Here a two-cell cloverleaf waveguide is tested under mockup conditions.



divided to form lighter nuclei). In spite of these great differences, the energy liberated by both kinds of bombs is nuclear energy, and the two development programs were equally at home in Los Alamos.

Since the Mike test, the people at Los Alamos Scientific Laboratory have proved their versatility again and again. Though LASL remains the nation's foremost center for nuclear weapon development (having created more than 90 per cent of all the fission and fusion warheads and weapons in the country's stockpiles), the Laboratory has greatly broadened its range of activities.

Only about one half of the total LASL effort is now devoted to weaponry. Other programs cover a broad spectrum of investigation and development looking toward peaceful uses of atomic energy.

Beneficial exploitation of the atom at Los Alamos actually began as soon as the Laboratory was founded. Though the whole first purpose of the installation was to develop nuclear weapons, the nature of that purpose entailed a great deal of purely scientific research. It required people and equipment fitted for much more than the creation of bombs.

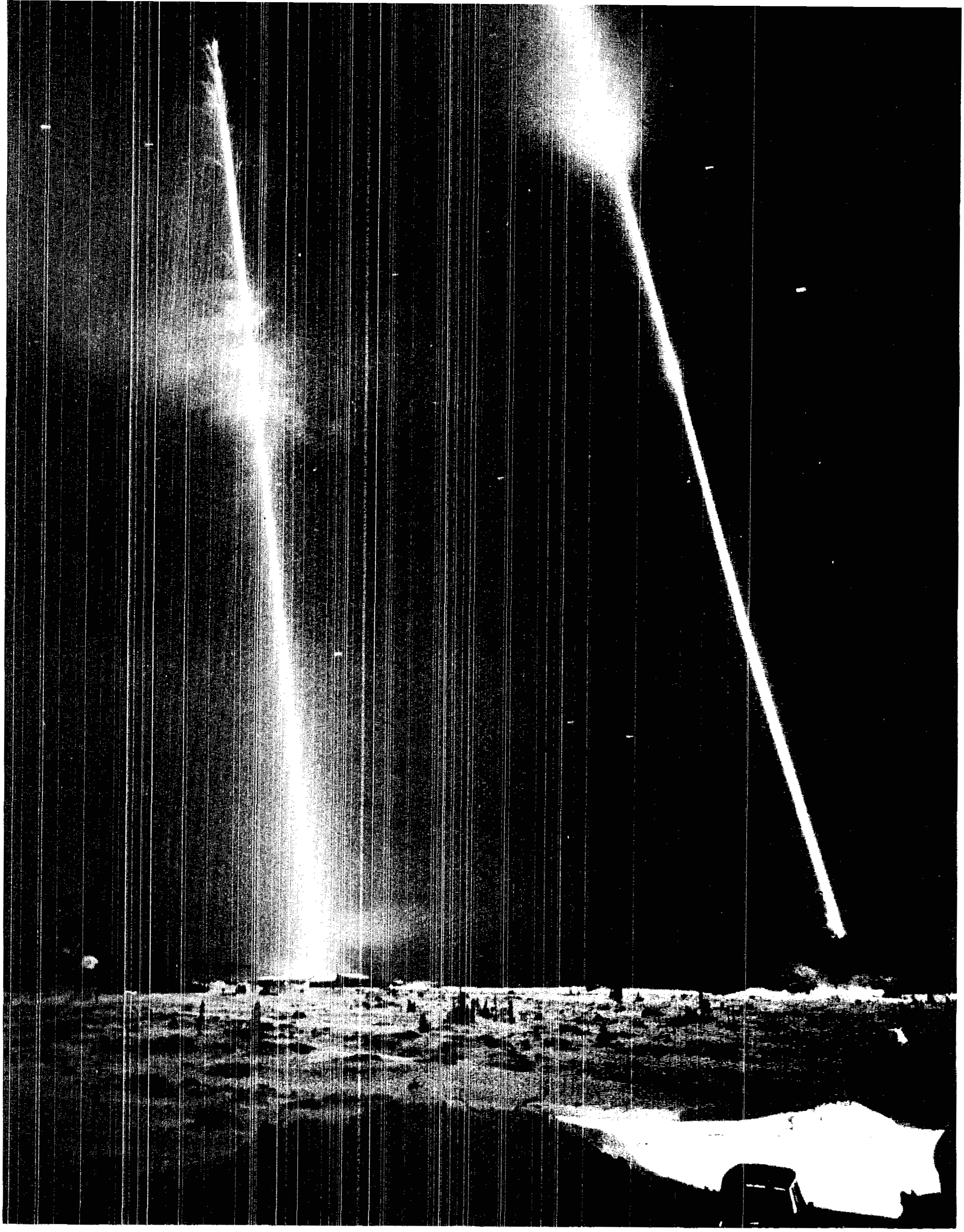
In addition to the enriched-uranium reactor development before Trinity, Los Alamos reactors using entirely different fuel systems have been created. One of them—the world's first plutonium-fueled reactor and the first to rely on a fast-neutron fission chain—went into operation in 1946. In more recent years the Laboratory has developed a reactor using uranium phosphate fuel and another using molten plutonium. One present goal of the Los Alamos reactor program is to find good ways in which to design "breeder" reactors—reactors using neutron capture reactions to produce more fuel than they consume.

Los Alamos has also created the first half-dozen rocket propulsion reactors (not intended to be flyable engines themselves, but designed to show the way toward the creation of propulsion systems far superior to those now in use).

Another peaceful program is Project Sherwood, in which ways are being sought to harness the H-bomb fusion reaction and make it do useful work.

Twenty years after Trinity, Los Alamos continues to make scientific and technological history. Reaching to the unknown is a hard habit to break.

Left: Looking to the future in space, Los Alamos this summer began the first of a long series of tests of the new Phoebus-type reactors, successsors to the famous Kiwis. Phoebus reactors, such as Phoebus I shown here during final assembly in Nevada, are intended for the higher power levels and longer life required for rocket engines for deep space missions.



A new reach to the unknown—probing the aurora borealis to investigate a region of the auroral spectrum beyond visible light known as the vacuum ultraviolet region. LASL launched two spectrometer-carrying Nike-Tomahawks from frigid Fort Churchill on Canada's Hudson Bay this spring.

SUMMERS COX
2531 B 46TH
LOS ALAMOS, N.M.

THE ATOM

Los Alamos Scientific Laboratory July 16, 1965

Special Twentieth Anniversary Edition